UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XV.

REPORT

With Compliments of

M McDonald

Commissioner.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1891.

UNITED STATES COMMISSION OF FISH AND FISHERIES.

PART XV.

REPORT

OF

THE COMMISSIONER

FOR

1887.

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1891.

Resolved by the Senate (the House of Representatives concurring), That the report of the Commissioner of Fish and Fisheries for the year 1887 be printed, and that there be printed 11,000 extra copies, of which 3,000 shall be for the use of the Senate, 6,000 for the use of the House of Representatives, 1,500 for the use of the Commissioner of Fish and Fisheries, and 500 for sale by the Public Printer, under such regulations as the Joint Committee on Printing may prescribe, at a price equal to the additional cost of publication and 10 per cent. thereto thereon added, the illustrations to be obtained by the Public Printer, under the direction of the Joint Committee on Printing.

Agreed to by the Senate February 27, 1889.

Agreed to by the House March 2, 1889.

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INTRODUCTORY.

The annual report of the Commissioner has heretofore been made for the 12 months included in the calendar year.

Since, however, several of the most important branches of the fish cultural work of the Commission, viz, the propagation of cod, lobster, salmon, trout of different species, and whitefish, are continuous throughout the winter, it is necessary, in order to give a complete and comprehensive account of each season's work, that the annual report should be made for the fiscal rather than the calendar year.

This report will therefore cover the operations of the Fish Commission for the 18 months comprised between January 1, 1887, and June 30, 1888. This period has been marked by important changes, as well in the organization and personnel of the Commission, as in its relations to other branches of the Government service.

The Fish Commission from its first establishment in 1871 was continuously under the direction of Professor Baird, until his death at Wood's Holl, Massachusetts, in the summer of 1887. An account of his distinguished services in behalf of the fishery interests will be given in my next report.

Immediately after the death of Professor Baird, at the request of the President, Dr. G. Brown Goode, Assistant Secretary of the Smithsonian Institution, assumed the commissionership, and performed the duties of the office for a period of about 6 months, until the law was modified and the present Commissioner appointed.

The following is a copy of the act amending the law concerning the U. S. Commission of Fish and Fisheries:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That section four thousand three hundred and ninety-five of the Revised Statutes of the United States be, and the same is hereby, amended to read as follows:

That there shall be appointed by the President, by and with the advice and consent of the Senate, a person of scientific and practical acquaintance with the fish and fisheries to be a Commissioner of Fish and Fisheries, and he shall receive a salary at the

rate of five thousand dollars a year, and he shall be removable at the pleasure of the President. Said Commissioner shall not hold any other office or employment under the authority of the United States or any State.

JOHN G. CARLISLE,
Speaker of the House of Representatives.
JOHN J. INGALLS,
President of the Senate pro tempore.

This act was approved by the President January 20, 1888, and Marshall McDonald was appointed Commissioner.

The report accompanying the act making the Commissioner of Fish and Fisheries a salaried officer of the Government follows herewith:

Mr. DUNN, from the Committee on Merchant Marine and Fisheries, submitted the following

REPORT:

[To accompany bill S. 261.]

The Committee on the Merchant Marine and Fisheries, to whom was referred the bill (S. 261) entitled "An act to amend the law concerning the Commissioner of Fish and Fisheries," have considered the same and report it back to the House without amendment and recommend its passage without delay.

The U. S. Fish Commission was established by act of February 9, 1871, which provided for the appointment by the President, with the consent of the Senate, of a Commissioner of Fish and Fisheries from among the civil officers or employés of the Government, who shall serve without additional salary. The act contemplated simply an investigation "with the view of ascertaining whether any, and what, diminution in the number of the food fishes" had taken place, and also what "protective, prohibitory, or precautionary measures should be adopted, and report upon the same to Congress."

The act of March 3 of the same year, to provide for deficiencies, etc., appropriated $5,000 for the expenses of the inquiry ordered.

Prof. Spencer F. Baird, then Assistant Secretary of the Smithsonian Institute, and an employé of the Government, he having charge of the National Museum, was appointed Commissioner. He prosecuted the inquiries with so much zeal, energy, and ability that the act of 1871 was reënacted, and the deficiency bill of May 18, 1872, made an additional appropriation of $3,500 to continue the inquiry, and $500 for the preparation of illustrations, tables, and report.

So impressed was Congress with the wisdom of Professor Baird's recommendations, based on the investigations he had made into the condition of our fisheries, that the act of June 10, 1872, contained an appropriation of $5,000 to continue those investigations during the fiscal year, and $15,000 was provided "for the introduction of shad into the waters of the Pacific States, the Gulf States, and of the Mississippi Valley; and of salmon, whitefish, and other useful food fishes into the waters of the United States to which they are best adapted." Each succeeding year appropriations have been increased as the work was extended under the wise and successful management of the Commissioner.

The act limiting the appointment of the Commissioner to a detail of some one at the time in the employ of the Government appears to have contemplated only an inquiry occupying perhaps a few summer months.

At the time of the selection of Professor Baird his duties under his salaried position were comparatively light, as he was charged with the administration, under the Secretary, of the Museum, which was in those days contained in the small space which could be allowed in the Smithsonian Building. Under Professor Baird's masterly,

wise, and energetic management, both the Fish Commission and the National Museum have grown to large proportions, so that at his death the work of the Fish Commission had developed from an inquiry in 1871, on an appropriation of $5,000, to the production, transportation, and distribution of over 100,000,000 young fish, and the administration of some sixteen hatching and rearing stations: Two in Maine, at Grand Lake Stream and Bucksport; two in Massachusetts, at Gloucester and Wood's Holl; two in Michigan, at Northville and Alpena; one at Duluth; one on the Columbia River; two in California, on the Sacramento; one on the Susquehanna, at Havre de Grace; one at the mouth of the Potomac; two within the city of Washington; one at Fort Washington, and one at Wytheville, Virginia, besides the administration of scientific investigations and fish hatching done by 3 steam and 1 sailing vessel, and of 3 transporting cars specially designed to transfer fish from one end of the country to the other.

The National Museum has had a corresponding expansion, for in addition to the hall of the Smithsonian which held the collections in 1871, and whose administration cost $20,000, a building covering 3½ acres has been built and equipped, and it has been found necessary to appropriate $168,000 for their care this year.

* * * Although the act of 1871 may have been prudent and a wise measure at the time it was enacted, and although the work of the Fish Commission as well as that of the Museum was well done by him, perhaps at sacrifice of some years of his valuable and honored life, it is to be doubted if, at the time of his appointment as Fish Commissioner, the Smithsonian, the National Museum, and the Fish Commission had been of their present magnitude, Congress would have provided for their conduct being placed even on his broad shoulders, and the work of three assigned to his well trained and cultivated intellect.

The work of the Fish Commission has become so extensive, and the results so important to the country, that it should be made, as this bill proposes, the sole object of the Commissioner—it should occupy all his time. This bill, therefore, while giving the President the greatest latitude in making his choice, takes away the limitation that that choice shall be confined to those who may be otherwise employed by the Government. This bill repeals the provision of the act of 1871, which requires that the now important and all-engrossing duties of the Fish Commissioner shall be performed at the expense of some other Department and some other appropriation.

Under the present law the Commissioner must either hold a sinecure, receive a Government salary, which he does not earn, or he must neglect duties for which he is paid in order that he might perform others for which he is not paid; or, perhaps, as in the case of Professor Baird, devote hours which nature demands for rest and recreation to Government work without compensation. The first two alternatives are neither right nor proper, and the Government is not so impecunious or needy that we should ask for it or accept such gratuitous services.

The rate of salary named in the bill is the same as has been fixed for and paid to the Assistant Commissioner for years.

With a Commissioner charged, as his sole duty, with the work of the Fish Commission there will be no further need for an Assistant Commissioner. The bill therefore does not contemplate any additional expense. The further details of the administration will be looked to when the appropriation bills are made up.

It is best not to encumber the present bill with other matter than the provision for the head of the Commission, as it is of the first importance that a permanent head of the Commission should be provided for at once. As soon as the new Commissioner provided for by this act shall have been appointed and installed he can be called before the committees of the House, and if further legislation be needed it can be predicated on his reports and after a revision of any projects for the prosecution of the work which he may submit.

Originating in an inquiry instituted by Congress "with the view of ascertaining whether any and what diminution in the number of the food fishes of the coast and lakes of the United States has taken place," the Commissioner was directed "should such diminution be ascertained to have taken place" to investigate the causes of the same and report to Congress "whether any and what protective, prohibitory, or precautionary measures should be adopted in the premises."

The fact that there had been a disastrous decline in the annual yield of both the coast and river fisheries of New England was clearly indicated by the investigations into the conditions of these fisheries, which had been conducted by the State authorities of Massachusetts, Rhode Island, and Connecticut.*

The fishery interests that were placed at a disadvantage by the introduction of pounds and traps sought, through their respective legislatures, to secure the enactment of laws prohibiting the use of fixed apparatus for the capture of fish.

The contention before the legislative committees charged with the consideration of the subject developed a great variety of opinions, which naturally grew out of the diversity and antagonism of interests involved, and led to the conviction on the part of those who desired to conserve the paramount public interest without making unfair or invidious discrimination in respect to the conflicting methods pursued, that the basis for rational legislation in respect to the fisheries could only be laid after a careful and comprehensive study of the matter in all its relations from a disinterested standpoint.

It was this informal consensus of opinion that led to the introduction into the House of Representatives by the Hon. H. L. Dawes, then a member from Massachusetts, of the joint resolution for the protection and preservation of the food fishes of the coast of the United States, which became a law on the 9th of February, 1871.

This bill, while responding to the immediate exigency and demand, is prophetic in the completeness with which it makes provision for that evolution of the Fish Commission by which it has come to be the conservator and custodian of an important economic resource for our people—a resource which can not, except in small measure, be appropriated or segregated by individuals, as our lands, our forests, and our mines may be and are, but which must for all time be maintained by the Government for the common use.

The alleged deterioration of the coast and river fisheries of New England having been abundantly confirmed by the investigations of

* The cause assigned by those who complained most of the result was the multiplication of traps and pounds which captured fish of all kinds in great numbers, and as was supposed in greater quantities than the natural fecundity of the fish could make good year by year, especially in view of the fact that these catches were made during the spawning season, thus destroying many of the fertile fish and preventing others from depositing their eggs. (S. F. Baird, Report of the Condition of the Sea Fisheries of the South Coast of New England in 1871 and 1872., p. 8.)

the Commissioner, his attention was next given to an inquiry as to the "causes of this deterioration and the protective, prohibitory, or percautionary measures to be adopted."

Omitting suggested causes, which were beyond the regulation or control of man, the result of the inquiry was to show that the agency of man was the most potential factor in bringing about this deterioration.

The injury was brought about directly by the multiplication of traps and pounds and by the absence of any restriction upon the season or methods of the fishery. Indirectly it was facilitated by the obstruction of streams by means of impassable dams and by the pollution of the waters with substances deleterious to the life of fish and to the maintenance of their natural spawning grounds. There was consequently a serious diminution in the natural reproduction of the shad and also of the herring and other anadromous species, which form a considerable portion of the food of important marine species along the coast.

The remedy for the decadence of the industry was to be found in the proper regulation of the fishing and in systematic and rational methods of propagation. These measures could be based only upon careful study of the methods and conditions of the fisheries and of the environment and habits of the fishes. In order to accomplish its objects the work of the Commission, outside of office administration, is therefore naturally concerned with the inquiry in regard to the food fishes, the study of the methods and conditions of the fisheries, and the conduct of fish-cultural operations. From this distribution of labor arose the divisions of administration, scientific inquiry, fisheries and fish culture.

Fish culture as a means of restoring the fisheries was first undertaken by the U. S. Fish Commission in 1872, being done at the suggestion of the American Fish Culturists Association, which appointed a committee of which Mr. George Shepherd Page was chairman to bring the matter to the attention of Congress. An appropriation of $15,000 for the purpose in question was made by Congress on June 10, 1872, and the Commission took immediate steps to inaugurate this important work, which in its development has come to be the principal agency for maintaining our most important commercial fisheries.

The species propagated in 1872 were as follows: The shad, the Maine salmon, the Rhine salmon, the California salmon, and the whitefish.

The organization outlined above was in effect during Professor Baird's lifetime, although never specifically defined and published by him. Realizing the advantage and necessity of a permanent guide for the operations of the Commission, the Committee on Merchant Marine and Fisheries drafted a bill which was introduced by Mr. Dunn in the House of Representatives April 30, 1888, providing for the reorganization of the Commission of Fish and Fisheries and defining its duties. Although this never became a law the organization proposed has been

adopted and the classification of the work and personnel made in substantial agreement with it. A copy of the bill is herewith given:

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That it shall be the duty of the Commissioner of Fish and Fisheries to continue the systematic investigation of waters of the United States, and of the biological and physical problems they present, with the object of determining the character, abundance, geographical distribution, and economical value of the inhabitants of the waters, both salt and fresh, as also their migrations, and the cause influencing or regulating the same. This investigation is to be conducted on a broad and comprehensive plan, so as to arrive at the life history of all species having economic value, as well as of those species to which they are intimately and essentially related.

SEC. 2. That he will continue the investigation into the history of the methods and apparatus of the fisheries and for the preservation and utilization of fishery products now in use, and will cause careful study to be made of new methods and apparatus introduced from time to time with the object of determining their effect upon production, and furnishing the information upon which to frame intelligent legislation regulating the conduct of the fisheries and improving their methods and apparatus.

SEC. 3. That it shall be the duty of the Commissioner of Fish and Fisheries to provide for the collection of the statistics of the fisheries of the United States, especial reference being had to the fisheries of the Great Lakes and of the New England and North Pacific coasts of the United States, which are of international importance and may influence or become the subject of treaty stipulations. The statistical inquiry hereby authorized and directed shall be comprehensively planned to accomplish the purposes for which it is instituted.

SEC. 4. That it shall be the duty of the Commissioner of Fish and Fisheries to continue the work of artificial propagation of food fishes and other useful inhabitants of the water with a view to their introduction into and establishment in the interior and coast waters, and to the maintenance and improvement of the important commercial fisheries of the coast and interior lakes and rivers. To this end he will, in his annual estimates transmitted to Congress, provide for the maintenance and operation of the existing stations of the Commission, and for the maintenance and operation of such additional permanent and field stations as may be from time to time authorized and directed.

SEC. 5. That the Commissioner of Fish and Fisheries shall appoint such employees as Congress may from time to time provide, with salaries corresponding to those of similar officers in other departments of the Government, and he shall, as Congress may from time to time provide, employ other persons, of expert knowledge, for such time as their services may be needed, including chemists, naturalists, and physicists, for the conduct of the researches and investigations required in the performance of the duties devolved upon this Department, or which may be from time to time authorized and directed by Congress.

PUBLICATIONS.

LIBRARY.

On January 1, 1887, the total number of volumes registered in the library of the U. S. Fish Commission had reached 3,000. Up to June 30, 1888, this number was increased to 3,857. At first the books comprising this collection were kept with those belonging to the Commissioner, Prof. S. F. Baird, in his private office; but in March, 1888, they were transferred to the office of the Commission, at 1443 Massachusetts avenue, and made accessible to all the employés of the Commission.

REPORTS AND BULLETINS.

The Report of the Commissioner for 1885, constituting part XIII of this publication of the Commission, relating to an inquiry into the decrease of food fishes and their propagation in waters of the United States, was published in 1887. Extra copies were issued of the following five papers included in this report: (1) Report on the work of the U. S. Fish Commission steamer *Albatross* for the year ending December 31, 1885, by Lieut. Commander Z. L. Tanner, U. S. Navy, commanding; (2) Report on the thermometers of the U. S. Commission of Fish and Fisheries, by J. H. Kidder, M. D.; (3) Report on the discovery and investigation of fishing grounds, made by the Fish Commission steamer *Albatross* during a cruise along the Atlantic coast and in the Gulf of Mexico, with notes on the Gulf fisheries, by Capt. J. W. Collins; (4) On the development of the cetacea, together with a consideration of the probable homologies of the flukes of Cetaceans and Sirenians, by John A. Ryder; (5) The Annelida Chætopoda, from Eastport, Me., by Prof. H. E. Webster and James E. Benedict.

The Bulletin of the Commission for the year 1886, a publication devoted to matters pertaining to fish-culture and to the apparatus, methods, and relations of the fisheries, was issued in 1887.

ARTICLES IN THE APPENDIX.

In 1885 Professor Baird began to collect information concerning the fisheries of the Great Lakes. He was led to make this investigation principally because of the supposed expansion in the products, value, etc., of the lake fisheries, the intimate relations existing between Canadian fishery enterprises and American markets, and the influence upon these fisheries of artificial propagation by the National and State fish commissions. It was believed that a consideration of the fishery relations between the United States and Canada might be somewhat influenced by a full knowledge of existing conditions in the Lake region. The work was carried on from August to November, 1885, and was under the direction of Mr. R. E. Earll, who was assisted by 6 employés of the Commission. The elaboration of the field notes and the compilation of the review have been delayed for various imperative reasons

until the present time. The labor of compilation devolved upon Dr. Hugh M. Smith and Mr. Merwin-Marie Snell, and the introduction and description of fishing vessels and boats were prepared by Capt. J. W. Collins, assistant in charge of the division of fisheries.

The review includes descriptions of the fishing grounds, sketches of the various methods of fishing, of the fishermen, the species of fish captured, the limits of the fishing season, the disposition of the catch, the statistics of the fisheries with reference to the influence of artificial propagation of several important species. Illustrations are given of the principal food fishes, fishing vessels and apparatus, the methods and processes pursued in various important fisheries, and there are maps of the fishing regions, together with charts showing the location of fixed apparatus. The work comprises 328 pages and 44 plates, besides numerous maps, charts, etc., and is the most important contribution to our knowledge of the Great Lake fisheries which has yet appeared.

The report on the work of the steamer *Albatross*, by Lieutenant Commander Tanner, consists chiefly of a narrative of the cruise of the *Albatross* from Norfolk to San Francisco, for the purpose of investigating the fishery resources of the Pacific Coast.

The steamer made upward of forty anchorages during the trip in various harbors of the West Indies, South America, Galapagos Archipelago, Mexico, and California. Shore collections were made at various points, and the dredge and trawl were used when opportunity offered. The scientific staff consisted of Prof. Leslie A. Lee, with Messrs. Thomas Lee and Charles H. Townsend as civilian assistants. The narrative gives a brief sketch of the regions visited, the inhabitants seen, and the collections obtained. Important hydrographic soundings were made during the voyage, and a valuable record of temperatures and specific gravities for the eighteen months ending June 30, 1888. The report is accompanied by four plates.

The report on the construction of the schooner *Grampus*, by Capt. J. W. Collins, the designer of the vessel, gives a complete history of the preparation of this schooner for the investigation of the fishing grounds and fisheries. It furnishes also complete details of the outfit carried by the vessel and the methods employed in conducting investigations.

The report is accompanied by 18 plates, showing interior and exterior views of the *Grampus* and of certain appliances and apparatus used in connection with her work.

The report upon the operations of the U. S. Fish Commission schooner *Grampus* from March 15, 1887, to June 30, 1888, by Capt. J. W. Collins and Capt. D. E. Collins, relates to investigations during the spring of 1887 of the mackerel, halibut, and cod fisheries and of the former habitat of the Great Auk. It contains also notes upon various species of fish and other aquatic animals observed during the cruise of this vessel. It gives important notes concerning the Newfoundland cod fishery, relative

to the vessels, boats, and apparatus employed, and the methods of catching and preserving fish. Another important investigation covered by this report is that of the southern mackerel fishing grounds in the spring of 1888. Incidental to this was the inquiry concerning the pound-net fisheries of Chesapeake Bay. The report is accompanied by numerous temperature records, and is illustrated by 16 plates.

Scientific investigations made on behalf of the Commission by Dr. David Starr Jordan, president of the University of Indiana, Prof. S. A. Forbes, director of the Illinois State Laboratory of Natural History, and Prof. Edwin Linton, of the Washington and Jefferson College, Washington, Pennsylvania, are made the basis of special reports by these authors. Dr. Jordan's contribution is a review of the Labroid fishes of America and Europe, in which he gives a systematic catalogue of all the species of this family of fishes (old wives, wrasses, doncellas, pudianos, parrot fishes, cunner, and tautog) found in the waters of America and Europe, with the synonymy of each species and analytical keys by which the various genera and species may be distinguished. This important monograph is accompanied by eleven plates, showing twelve of the one hundred and fifteen species discussed.

The article by Professor Forbes on "Some Lake Superior Entomostraca," is a valuable contribution to our knowledge of the crustaceans of Lake Superior. It has an important economic relation to some difficult problems of fish-culture in the Great Lake region, since the minute crustaceans treated by Professor Forbes constitute the principal supply of food for the young of several valuable edible species. The paper contains descriptions of several new species and two new varieties of Entomostraca, and is illustrated by four plates.

The notes on the Entozoa of marine fishes of New England, with description of several new species, is the second part of a series of papers by Prof. Edwin Linton, of the Washington and Jefferson College, Washington, Pennsylvania. It comprises 149 pages of text and 15 plates, and relates to forty-two species of Cestod worms, of which twenty-seven are described as new to science, eight of these representing new genera.

These parasites were found in a variety of fishes, but principally in the sharks and rays. This is one of the most important contributions to the subject of fish parasites which has been given to the public.

RELATIONS OF THE COMMISSION.

The Commission has continued to coöperate with the fish commissions of various States and with the fish-culturists of foreign countries in the effort to increase the productiveness of the waters. Every active State fish commission has received at various times from the United States supplies of eggs to be developed in its hatcheries, or of young fish to be distributed in suitable waters. The species allotted to Commonwealths in this way include all of the native *Salmonidæ* reared in establishments of the United States, as well as the species obtained by exchange with foreign governments. The list includes the whitefish, Maine salmon, landlocked salmon, rainbow trout, brown trout, Loch Leven trout, sälbling, brook trout, lake trout, shad, carp, goldfish, and the lobster. Some of these fishes are reared through the coöperation of States with the United States. The station at Bucksport, Maine, for instance, which is engaged in the cultivation of the Penobscot salmon, is operated by the United States and the State of Maine. The Schoodic Station at Grand Lake Stream, Maine, cultivates the landlocked salmon, and is operated on the joint account of the United States, New Hampshire, and Massachusetts. At the Cold Spring Harbor Station, of the New York Fish Commission, the United States is allowed the privilege of hatching and distributing salmon, whitefish, shad, and various kinds of trout. In the transportation of shad to the headwaters of the Delaware River, the Pennsylvania Commission extended the assistance of its messengers. The Michigan Fish Commission donated to the United States about 20,000,000 whitefish eggs out of their supply obtained from Detroit River.

FOREIGN GOVERNMENTS.

The system of international exchanges, which has been so productive of good results heretofore, has been continued and extended. The United States Commission has received living soles from Mr. Thomas J. Moore, of Liverpool, England; Loch Leven trout from Sir James G. Maitland, Howietoun, Scotland; sälbling and brown trout from Herr von Behr and Herr Max von dem Borne, of Germany. Whitefish eggs have been forwarded to England, Germany, and New Zealand; eggs of the landlocked salmon to England, France, and Germany; eggs of the rainbow trout have been shipped to England, France, Germany, Switzerland and Mexico. Brook trout eggs were forwarded to England, as were also eggs of the lake trout. All of these are referred to in detail in the tables of distribution.

RELATIONS WITH OTHER DEPARTMENTS OF THE UNITED STATES GOVERNMENT.

The Commission has continued to receive assistance from the heads of various Departments of the Government, and its operations have been greatly facilitated by means of such aid.

To the *Secretary of the Navy*, Hon. W. C. Whitney, the Commission is under special obligations for details of officers and men to its vessels engaged in the Divisions of Inquiry and Fish-culture, as well as for necessary facilities for outfitting and repairing its vessels in the navy-yards. The *Bureau of Construction and Repair* lent launch No. 55 for the use of the Commission in the shad propagation at Havre de Grace, Maryland. A dredge was lent to the Commission by the *Bureau of Yards and Docks*, and the *Hydrographic Office* furnished the charts required for outfitting the schooner *Grampus*.

The *Treasury Department* has granted the withdrawal of alcohol from bonded warehouses and the free entry of coal for the use of the Fish Commission vessels. The Department has also admitted free of duty a submarine cable for the use of the Commission, galvanized rope required for dredging, and a package of preserved fish from Scotland. The *Bureau of Navigation* has continued to furnish valuable data concerning fishing vessels. The *Light-House Board* on the 9th of November, 1887, granted to the Fish Commission for a hatchery site, a portion of Ten Pound Island, in the harbor of Gloucester, Massachusetts. It has supplied vessels of the Commission with publications of the Board, which are necessary for the navigation of the coast, and has forwarded temperature observations from thirty-three light-houses and ships, covering almost the entire region from Maine to Florida. The *Life-Saving Service* has contributed to the efficiency of the Commission by reporting by telegraph, through the keepers and patrolmen, the stranding of fish and other marine animals in the various precincts. The *Coast and Geodetic Survey* has furnished many necessary charts, time tables, etc.

To the *Secretary of War*, William C. Endicott, the Commission is indebted for the privilege of quartering its employés in the commandant's residence at Fort Washington during the season of shad hatching. The *U. S. Signal Office* has examined and approved a submarine cable, which was imported for the use of the Fish Commission, and has furnished temperature observations from sixteen important and widely separated localities in the United States.

The *U. S. Geological Survey* has lent a boiler and engine for the use of the Fish Commission.

The *Commissioner of Patents* has furnished copies of specifications of patents relating to fishing apparatus and the fisheries.

In the office of the *District Commissioners*, the *Health Officer*, Dr. Smith Townshend, has furnished monthly statistics of the fishes in the markets of Washington.

RELATIONS TO INDIVIDUALS.

Acknowledgment is due to Mr. Marshall E. Morris, of Bridgeport, Connecticut, for the use of his steamer for the oyster investigation in 1887. Mr. S. J. Seneca, of Havre de Grace, Maryland, allowed the Commission to use a part of his counting house, which was fitted up with 100 shad-hatching jars, besides furnishing all the water needed for hatching.

To Capt. L. L. Blake and Purser Adams, of the steamer *W. W. Corcoran*, of Washington, District of Columbia, thanks are due for aid in the shipment of shad eggs; and to Mr. George L. Sheriff, of Washington, District of Columbia, for the free use of his wharf for the Fish Commission launch.

The Commission has received some distinguished visitors from foreign countries on missions of inquiry concerning fisheries and fishery investigations. Count Kmoda, an official of the Japanese Court, was provided with information on the utilization of fish products; and Mr. K. Ito, Superintendent of Fisheries of Japan, was given many facilities for investigating the subjects in which he is interested. In September, 1888, Rev. W. S. Green, of Dublin, Ireland, visited the Wood's Holl Station of the Commission, and obtained many data of practical utility concerning the fisheries.

In the account of the division of scientific inquiry will be found references to persons who were engaged in the laboratory at Wood's Holl, Massachusetts, and in collaborating reports for the Commission.

RELATIONS TO INSTITUTIONS.

On the 6th of January, 1887, Mr. Vinal N. Edwards, of Wood's Holl, on behalf of the Commission, shipped a live seal to the Zoölogical Gardens, Philadelphia, Pennsylvania.

RELATIONS TO TRANSPORTATION COMPANIES.

To the Duluth and Iron Range Railroad Company the Commission is indebted for granting the right of way over its grounds for a water flume, and for the privilege of suspending the same from one of its bridges at Duluth. The Norfolk and Western Railroad Company, at the request of the Commission, has made Wytheville Station a flag station for all local freight trains.

In the work of distribution from January 1, 1887, to June 30, 1888, inclusive, 176,027 miles were traveled by the cars of the Commission and the detached messengers engaged in the service. Of this mileage, free transportation was furnished the Commission cars by railroads of the country, as follows:

Summary showing name of railroad and total number of miles of free transportation furnished the U. S. Fish Commission cars by the railroads from January 1, 1887, *to June* 30, 1888.

Railroad.	Miles.	Railroad.	Miles.
Canada Southern	459	Missouri Pacific	1,622
Chesapeake and Ohio	104	Mobile and Ohio	40
Chicago, Burlington and Quincy	262	Northern Pacific	2,087
Chicago and Grand Trunk	553	Old Colony	19
Chicago and West Michigan	54	Oregon Railway and Navigation Company	404
Detroit, Bay City and Alpena	630	Rome, Watertown and Ogdensburgh	346
Eastern	216	St. Louis, Iron Mountain and Southern	980
Eureka Springs	26	St. Louis and San Francisco	351
Flint and Pere Marquette	3,561	St. Paul and Duluth	304
Florida Railway Navigation Company	414	South Florida	230
Grand Rapids and Indiana	620	Texas Pacific	738
Illinois Central	425	Utah Central	600
Lake Shore and Michigan Southern	947	Wabash, St. Louis and Pacific	264
Louisville and Nashville	11	Western and Atlantic	170
Maine Central	272	Wisconsin Central	462
Mexican Central	2,448	Total	21,560
Michigan Central	1,941		

DIVISIONS OF THE COMMISSION.

DIVISION OF FISH CULTURE.

For the present the Commissioner has retained immediate and personal direction of the work of artificial propagation and distribution, and to relieve himself as far as practicable from the details of administration has designated an inspector of stations and a superintendent of distribution.

In view of the increasing number of fish-cultural stations and their distribution over all sections of the United States, the services of an inspector will be in constant requisition, to maintain intelligent supervision of the stations and prevent irregularities and abuses.

The increasing production of the stations and the wider area over which the distribution is to be made render the services of a superintendent of distribution equally indispensable for the effective regulation of the car and messenger service.

These offices will constitute an integral part of the permanent organization of the personnel of the Commission, which should as soon as practicable be established by law and the classification of the service and the rates of compensation specifically prescribed.

The effective work of the stations is measured by the number of fish and eggs furnished each season for distribution. This is increasing each year, with a proportionate decrease in the cost of production.

The total production for the fiscal year 1887–'88 is given in the following table, and for convenience of reference is arranged by stations and species.

STATION REPORTS.

Fish and eggs furnished for distribution by the stations for the year ending June 30, 1888.

Stations.	Species.	Eggs.	Fry.	One year old.	More than 1 year old.
Alpena, Mich	Whitefish		18,000,000		
Baird, Cal	Rainbow trout	251,000	78,000	5,000	2,000
Battery, Md	Shad	17,408,000	62,641,000		
Bucksport, Me	Atlantic salmon	924,000			
Carp Ponds, Washington, D. C.	Carp for public waters		38,497		
	Carp for private ponds		131,656		
	Goldfish		5,049		
Central Station, Washington, D. C.	Shad	13,351,000	39,664,000		
	Rainbow trout		20,000		
	Lake trout		20,000		
	Brook trout		20,000		
	Whitefish	2,412,000	500,000		
Cold Spring Harbor, N.Y.	Rainbow trout		23,500		
	Landlocked salmon		34,000		
	Atlantic salmon		459,200		
	Sälbling	7,417			
	Whitefish		800,000		
	Lake trout		85,200		
	Brown trout		54,000		
Fort Washington, Md.*	Shad		1,475,000		
Gloucester, Mass	Codfish	189,432	627,040		
Grand Lake Stream, Me	Landlocked salmon	345,000			
Northville, Mich	Whitefish	30,000,000			
	Lake trout	547,000			560
	Brook trout	215,000			45
	Rainbow trout	10,000		8,578	10
	Brown trout	5,000		1,000	10
	Loch Leven trout	50,000			
Steamer *Fish Hawk* (Delaware Bay).	Shad	8,336,000	30,851,000		
Wood's Holl, Mass	Codfish		8,843,600		
	Lobsters	196,000			614
	Flounders		220,000		
Wytheville, Va	Brook trout			11,235	6
	Rainbow trout	80,000		18,618	150
	Landlocked salmon		11,400		
	Redeye perch			3,075	30
	Black bass			550	
	Carp		4,524		733
	Goldfish		388		
Total		74,326,849	164,607,054	48,056	4,158

* At this station 70,249,000 shad eggs were taken and transferred to Central Station for hatching and distribution.

GLOUCESTER STATION, MASSACHUSETTS, E. M. ROBINSON, SUPERINTENDENT.

For several years the Commission has prosecuted steadily at the Wood's Holl Station experimental investigations looking to the development of methods and apparatus for hatching the floating eggs of the cod, haddock, and other important commercial species. Prior to 1885 the investigations had not passed the experimental stage, nor were the results obtained very encouraging. Each season, however, some advance to practicable methods was secured, the causes of failure being, one by one, ascertained and eliminated, and the conditions for success established.

In the winter of 1885-'86 Captain Chester, superintendent of the Wood's Holl Station, devised a modification of the McDonald tidal apparatus, by the use of which he succeeded in hatching a very considerable per cent. of the ova of the cod, and made it practicable to undertake extensive and systematic fish-cultural work with all the marine species affording buoyant or floating eggs.

In the winter of 1886-'87, some seven million young codfish were hatched out and turned into the adjacent waters of Vineyard Sound and Buzzard's Bay. The methods for the profitable conduct of fish-cultural operations with the marine species having been determined, it was decided by the Commissioner, Prof. G. Brown Goode, to establish an auxiliary station at some point on the coast of Massachusetts, north of Cape Cod. Gloucester Harbor was finally selected as the location for this station, for the reason that it is conveniently situated with reference to the fishing grounds, which are easily reached either by the vessels of the Commission or by the numerous fishing vessels which go out from Gloucester to the inshore grounds and to Ipswich Bay.

The Light-House Board, responding promptly and courteously to the request of the Commissioner, gave permission to locate the proposed station on Ten Pound Island. Plans were prepared, the site occupied, and arrangements to begin the construction of the station were perfected early in November, 1887. The work was pushed with the utmost dispatch; and, after vexatious delays on account of unfavorable weather, the station was completed and equipped ready for work on January 8, 1888.

The favorable season for work had then passed, and the extremely cold weather that immediately supervened and continued during January and February kept the temperature of the water in the hatchery below the point at which hatching operations can be successfully carried on. A temperature below 30° kills the eggs which have reached a certain stage of development, and when it descends to 28°, both old and young fish succumb and perish.

The season's work was valuable rather for the experience secured by the personnel employed, and the opportunity to study the necessary conditions for success in future operations, than for the material results obtained.

The total number of eggs obtained was 32,449,000; the average loss during incubation was 90 per cent.; the largest percentage of fish obtained from any single lot being 15 per cent.

WOOD'S HOLL STATION, C. G. ATKINS, SUPERINTENDENT.

This station is thoroughly equipped, as well for marine biological research as for the most extensive fish-cultural operations. Reference will be made here only to the fish-cultural work carried on during the year.

The investigations conducted in the biological laboratory by the regular and volunteer scientific assistants engaged in the study of the marine life of the waters adjacent to the station will be referred to under the head of inquiry in respect to food fishes and the fishing grounds.

As heretofore, the most extensive fish-cultural operations were with

The Codfish.

The total number of eggs taken was 30,088,000; the number of fry hatched, 7,822,000, the average percentage of production being 26 and the highest percentage 92½. The heaviest losses were during January, when the temperature of the waters was lowest. It would appear that a temperature of 30° or below is certainly fatal, both to fish and eggs.

The high percentage of production obtained in a number of cases would indicate that, when the necessary conditions of success are precisely ascertained, we may count on as good results with the codfish as with the shad and whitefish.

A number of experiments were made to transfer eggs from Gloucester to Wood's Holl, but without satisfactory results in any case. The young fish obtained were all planted in the waters of Buzzard's Bay and Vineyard Sound, in the vicinity of the station, with the exception of one lot of 894,000, which were delivered to the *Fish Hawk* for transfer to Long Island Sound and Chesapeake Bay.

The Winter Flounder.

An application by Prof. Benjamin Sharp, of the University of Pennsylvania, for material for the study of the embryology of the flat fishes was the occasion of some interesting experiments and observations on the breeding and artificial hatching of the common flounder.

This species was obtained in breeding condition early in February. The eggs were found to be extremely adhesive, and, if permitted, would aggregate in great lumps. The best success was obtained by spreading them thinly on panes of glass and placing them in a current of water. The total number of eggs collected was 1,179,000, from which were produced 320,000 fish, which were placed in the waters of Vineyard Sound.

Lobsters.

Of this species 2,092,000 eggs were taken, from which a consignment of 193,000 was sent to the Pacific coast. The rest were hatched and turned out in waters adjacent to the station.

Other species incubated at the station were as follows: Mackerel, scup, tautog, and sea bass. With each species fair results were obtained, showing that our present methods and apparatus can be applied to these fish when the necessity for their artificial reproduction becomes apparent.

ST. JEROME STATION, MARYLAND.

This station is occupied under a lease, which will expire in 1889. It is in the custody of a watchman. No active work has been carried on there during the present year, nor is it proposed to continue such in future. The station will be abandoned on the expiration of the present lease.

THE MAINE STATIONS.

The Maine stations are under the direction of Mr. C. G. Atkins as superintendent. During the present season the active direction of the work of the stations has been intrusted to the assistant superintendent, Mr. W. O. Buck, Mr. Atkins being in immediate charge of the Wood's Holl Station, and engaged in a series of investigations having for their object the improvement of methods and apparatus for hatching eggs.

THE SCHOODIC STATION.

This station, at Grand Lake Stream, is operated on the joint account of the United States, New Hampshire, and Massachusetts. Its object is the collection of the ova of the landlocked salmon for distribution, with the view to acclimation in other sections of the country where the waters offer favorable conditions. One-third of the eggs taken are reserved and hatched out and the young planted in Grand Lake Stream. The rest are allotted to the contributors to the expenses of the work, the quotas being proportioned to the amounts contributed by each of the participants. Under this arrangement the United States received 345,000, which were distributed as follows:

Iowa State Commission	10,000
Pennsylvania State Commission	10,000
New York State Commission	50,000
Michigan State Commission	50,000
Maine Commission	50,000
Vermont Commission	50,000

These consignments were all received in the very best condition. Ten thousand eggs were sent to Wytheville Station, Virginia, and the same number to Bucksport Station, Maine, to be hatched and held for a year in the rearing ponds before turning out into open waters. A

consignment of 50,000 eggs was sent to the Deutsche Fischerei Verein, in return for consignments of eggs of the European trout, and 10,000 eggs were forwarded to the Department of Agriculture of France, in response to request made through official channels.

BUCKSPORT STATION.

This station has for its object the collection and incubation of the eggs of the Penobscot salmon. When the eggs have reached such development as to permit safe transportation they are forwarded to their various destinations. The allotments are made to New England waters principally, since it is only in this section that we find streams affording suitable conditions. It is thought probable that salmon may be established in the Hudson River, and with this view it is proposed, in coöperation with the New York Commission, to continue the systematic stocking of its headwaters for several years longer. This station, like the Schoodic Station, is operated jointly by the United States and the State of Maine. The quota of eggs received by the United States the present season was 924,000, which were distributed as follows:

New York Commission	500,000
Rhode Island Commission	50,000
New Hampshire Commission	50,000
Vermont Commission	50,000
Massachusetts Commission	50,000
Maine Commission	148,000
Benj. Lincoln, for the Dennis River, Maine	40,000
Reserved for rearing at Craig's Brook Station	36,000

The fry obtained will be liberated in ponds and fed until they have attained a length of several inches before turning out into open waters. It must be confessed that the results obtained from planting the fry of the *Salmonidæ* are often disappointing. On the other hand, the results of stocking with fingerlings are immediate and assured, and it is proposed to extend this work as rapidly as the requisite facilities can be provided at the stations.

BAIRD STATION, LIVINGSTON STONE, SUPERINTENDENT.

This station was established in 1879 for the propagation of the Rainbow Trout (*Salmo irideus*), and from it has been drawn the eggs to furnish a stock of breeders for the Eastern stations. The species is now well established at Northville, Michigan, and Wytheville, Virginia, and in the breeding ponds of various State commissions. We will be able in future to meet all requests for eggs with the product of Eastern stations.

In view of this fact it has not been deemed advisable to continue the Baird Station in active operation. Accordingly, at the end of the season in June, the station was closed, and the serviceable property removed to the salmon station on the McCloud River about 4 miles below.

At first it was contemplated to transfer the magnificent collection of breeding fish to our Eastern stations, but this was found to be impracticable, and instructions were given to plant them in the tributaries of the McCloud River in the vicinity of the station. The number deposited was as follows: 2,000 large breeders, 5,000 yearlings, and 80,000 fry.

The number of eggs obtained during the season was 443,000, which were disposed of as follows:

To R. O. Sweeny, commissioner of fisheries for Minnesota, 38,000.

To Otto Gramm, commissioner of fisheries for Wyoming, 25,000.

To E. Cházari, commissioner of fisheries for Mexico, 33,000.

The latter shipment was made in response to a request of the Mexican Government through our Department of State.

The rest were retained to be hatched at the station.

McCloud River Station, California, Livingston Stone, Superintendent.

This station has not been in operation since 1883, the building being in charge of a custodian or watchman.

The necessity of artificial propagation with the view of keeping up the salmon fisheries of the McCloud River has become so evident that it was determined to resume work there. Accordingly Mr. Livingston Stone was instructed to have the buildings put in repair and all necessary arrangements made for the operation of the station during the fall and winter of 1888. During the spring of 1888 arrangements were made for placing the usual rack and bridge across the McCloud, to stop the salmon ascending the river and for raising water to the hatching house. In 1881 the original hatching house was carried away by the high water, and to avoid a recurrence of this the present one was built on a higher level, and pumps are used for raising the water for hatching. A 12-foot current wheel was placed in the river to furnish power to run the pumps. A spawning building and other appliances for taking eggs were constructed and made ready, and the hatchery and hatching apparatus put in order for receiving eggs. The work of preparation is progressing favorably, and the station will be ready for efficient work when the spawning season begins in August.

Clackamas Station, Oregon, Livingston Stone, Superintendent.

Provision was made for the establishment of a salmon hatchery on the Columbia River, its tributaries or their branches, by the sundry civil bill, which became a law March 3, 1887, the sum of $10,000 being appropriated for this purpose. The act further provided "that if in the opinion of the United States Fish Commissioner the existing laws of Oregon and Washington are not sufficient for the protection of salmon in the Columbia River and its tributaries, this appropriation shall not be available until the legislatures of the State of Oregon and Washington Territory shall have enacted such additional legislation as in the

opinion of the Fish Commissioner shall be necessary to protect the salmon from improper capture and destruction."

The then Commissioner of Fisheries, Prof. G. Brown Goode, after satisfying himself that the existing legislation of Washington and Oregon was in substantial compliance with the provisions of the act of appropriation, made arrangements to carry the instructions of Congress into effect.

Accordingly Mr. Livingston Stone, who had previously been in charge of the salmon work on the McCloud River, California, was assigned to duty and instructed to proceed to the Pacific coast and establish a salmon-breeding station somewhere on the Columbia River or its tributaries.

He was instructed if possible to secure the site on the Clackamas River, which was the property of the Washington and Oregon Fish Propagating Company, and then occupied under lease by the State fish commission of Oregon.

This was accomplished after various difficulties and delays, the fish propagating company having generously conveyed their property in fee simple to the United States and the Oregon commissioners surrendering their lease in consideration of reimbursement for expenditures incurred in the construction and equipment of the station.

It is confidently expected that arrangements for transfer and occupation will be completed in time to begin the collection of eggs the ensuing season and thus inaugurate a work which will doubtless in time contribute much to the improvement of the salmon fisheries of the Columbia River.

Michigan Stations, F. N. Clark, Superintendent.

NORTHVILLE STATION, MICHIGAN.

The operations at this station during the present season have been conducted, as heretofore, under the immediate direction of Mr. F. N. Clark, and include the propagation and distribution of the whitefish, lake trout, brook trout, California trout, brown trout, and Loch Leven trout.

The results obtained during the season with the different species have been very satisfactory, and this is especially so with reference to the California trout and brook trout.

Whitefish.

The hatching of the eggs of the whitefish at this station has been intermitted during the present year, and it is proposed to confine this work in the future exclusively to the Alpena Station. Of the eggs obtained, however, 30,000,000 were shipped to Northville where they were overhauled, repacked, and forwarded to applicants, 15,000,000 having been sent to the Pennsylvania commission, 10,000,000 to the Minnesota commission, 4,000,000 to Central Station, Washington, District of Co-

lumbia, and 1,000,000 to Fred Mather, Cold Spring Harbor, New York, which were hatched out and deposited in waters of Long Island. Reports received indicate that the eggs reached their destination in splendid condition in every instance.

Lake Trout.

After an intermission of one year the collection of the eggs of this species was resumed the present season, the total number collected being 1,300,000 eggs. The first eggs were taken on October 15, and the season closed about November 20. During the winter 462,000 eggs were forwarded to State fish commissions, 45,000 to the National Fish Culture Association, London, England, and 40,000 to Central Station, Washington, District of Columbia. Of the balance 50,000 fry were hatched out and retained at the station. On December 16, 1887, 560 2-year-old lake trout were planted in Long Lake, Alpena County, Michigan.

Brook Trout.

Very gratifying success has attended the work with this species the present year, the total production of eggs being 274,600, of which 175,000 were forwarded to State commissions and 40,000 to Central Station, Washington, District of Columbia. Of the remainder 45,000 fry were hatched out and retained at the station for future distribution. All of the shipments reached their destination in very good condition.

Rainbow Trout.

The best results received from this species in the history of the station, both in the number of eggs and the percentage of good eggs taken, have been obtained the present season. The total number of eggs taken was about 325,000, of which 225,000 were good. It is the intention to hold and rear as many as possible of this fish until they are able to take care of themselves, when they will be distributed to suitable waters Very few of the eggs, therefore, were shipped the present year, only one lot of 10,000 having been forwarded to the Castalia Club, of Castalia, Ohio. The first eggs were taken on December 8, and the season closed May 4. The total production of fry was 157,000, which were retained at the station. During the season 8,578 one-year-old fish were distributed to open streams, lakes, and applicants for ponds in Michigan, Missouri, Ohio, Indiana, Arkansas, Tennessee, and Kansas, the greater part of the distribution having been done by Fish Commission car No. 1.

Brown Trout.

Of this species 26,763 eggs were taken from fish raised from the original stock of eggs received in the spring of 1883 from Germany. Five thousand of these were forwarded to the Michigan commission, and 18,000 retained at the station. The success with this fish in the fry state has not been very satisfactory, the mortality being considerable during the first 3 months. After this time, however, they feed well and grow rapidly, the loss being almost imperceptible. On December 20, 1887, 500 one-year-old trout were forwarded by car No. 1 to the Michi-

gan Fish Commission, and in January, 1888, a similar number of yearlings were planted in the north branch of Tobacco River, Michigan.

Loch Leven Trout.

This fish promises to become very popular for pond culture, being very hardy, and not likely to be attacked by fungus. During the season 176,730 eggs were taken from 600 fish of this variety. Of this number 50,000 were forwarded to State fish commissions and 85,000 hatched out and retained at the station for future distribution.

ALPENA STATION, MICHIGAN.

Whitefish.

A very fair season's work has been done with this fish, notwithstanding the fact that no eggs have been obtained from Lake Erie, on which we had previously relied for our greatest supply. The collections this year were made in Lakes Huron and Michigan, the eggs for shipment being forwarded to Northville, and those to be hatched out held at this station. Of the 18,000,000 fry hatched out, 15,000,000 were deposited in Lake Huron, 1,000,000 in Lake Michigan and 2,000,000 in Long Lake, Michigan. This station is also under the immediate direction of Mr. F. N. Clark.

WYTHEVILLE STATION, VIRGINIA, GEORGE A. SEAGLE, SUPERINTENDENT.

Rainbow Trout.

The most noteworthy features in the operation of the station during the season were the increase in the production of eggs of the Rainbow trout and the extensive distribution of yearling fish of this species. The total production of eggs for the season was 300,500, as against 220,500 during the previous season. Of the number of eggs produced, 75,700 were lost in incubation, 45,000 forwarded to foreign governments, and 35,000 to the Commissioners of Fisheries of New Hampshire and West Virginia. The total number of fry released in rearing ponds at the station was 99,870. Fifteen hundred and thirty-five yearling trout were distributed to seventeen applicants for ponds in Virginia, North Carolina, and Tennessee, 11,875 to streams in Virginia and North Carolina, and 5,208 were forwarded to Central Station, Washington, District of Columbia, for distribution. There were also supplied to two applicants for ponds in Virginia 150 trout 3 years old.

The following is a summary of production and distribution of eggs and yearlings of this species:

Total number of eggs produced at station		300,500
Total number of eggs received from other stations		15,000
		315,500
Aggregate losses during incubation	75,700	
Number of eggs shipped from the station	80,000	
		155,700
Total number of fry hatched out		159,800
Losses of fry up to time of transfer to rearing ponds		59,930
Total number released in rearing ponds		99,870

DISTRIBUTION.

To the National Fish-culture Association, London, England	eggs..	25,000
To C. S. White, Commissioner of Fisheries, Romney, West Virginia	do...	10,000
E. B. Hodge, Commissioner of Fisheries, Plymouth, New Hampshire	do...	25,000
To the Government of Switzerland	do...	20,000
		80,000

To eighteen applicants for ponds in Virginia, North Carolina, and Tennessee, yearlings		1,535
To streams in Virginia	yearlings..	6,375
	3 years old..	150
To streams in North Carolina	yearlings..	5,500
To Central Station, Washington, District of Columbia, for distribution	do...	5,208
		18,768

Brook Trout.

The first eggs ever procured from the brook trout at this station were taken in October, 1887. In consequence, however, of heavy mortality in the eggs during incubation and subsequently in the young, only 2,966 fry were saved out of 25,000 eggs collected at the station and 10,700 fry received from Northville, Michigan. These were transferred to rearing ponds at the station. The number of yearlings of this species forwarded from the station during the season was 10,735, as against 3,238 the previous year. Of this number 1,010 yearlings were supplied to nine applicants in Virginia and Tennessee, 7,225 planted in streams of Virginia, and 2,500 forwarded to Central Station, Washington, District of Columbia, for distribution.

Statement of production and distribution.

Number of eggs produced at the station	25,000
Aggregate losses during incubation	16,022
Number of fry produced at station	8,978
Number of fry received from other stations	10,700
	19,678
Losses to time of transfer to rearing ponds	16,712
Released in ponds	2,966

DISTRIBUTION.

To nine applicants in Virginia and Tennessee	yearlings..	1,010
To streams in Virginia	do....	7,225
To Central Station, for distribution	do....	2,500
		10,735

Black Bass.

No arrangements having been made with a view to the production of this species for distribution, such numbers as are required to meet occasionally urgent demands are procured by collection from waters in the vicinity of the hatchery. During the season there were obtained in this manner 550 yearling small mouth black bass, of which 300 were

supplied to three applicants in the State, 200 to streams in Bath County, Virginia, and 50 forwarded to Central Station, Washington, District of Columbia.

Red-eye Perch.

Such distribution of this species as has been made up to this time has also been the result of collections from streams convenient to the station. The total number collected the present year, was 6,628; 3,523 of these were retained at the station, 580 supplied to five applicants for ponds in Virginia, 400 planted in the headwaters of the Shenandoah River, Virginia, 600 in streams in Bath County, Virginia, and 1,525 forwarded to Central Station, Washington, District of Columbia, for distribution.

Lake Trout.

Twenty thousand fry of this species were received on April 6, 1888, from Central Station, Washington, District of Columbia. In this lot there was a loss of 7,873, leaving 12,127 healthy fry, which were released in rearing ponds at the station.

Brown Trout.

On March 23, 1888, there was received from Cold Spring Harbor, New York, a lot of 15,263 eggs of the brown trout, from which not very satisfactory results were obtained. The total number of fry produced was 14,394, there being a loss in incubation of only 869 eggs. There was, however, heavy mortality in the fry, which proved a total loss.

Land-locked Salmon.

One lot of 20,000 eggs of this fish was received on March 1, 1888, from Grand Lake Stream, Maine. The loss of eggs during incubation and the subsequent loss of fry reduced the number to 11,400 fish, which were deposited in the headwaters of the Shenandoah River, Virginia, May 16, 1888.

German Carp.

The total production of this fish at the station was about 600,000. There were also received from the carp ponds, Washington, District of Columbia, during the summer of 1888, 440,000 fry, which were released in rearing ponds. Not very favorable results, however, have been obtained the present year in the attempt to hold and rear this species at the station. During the fall and winter of 1887 4,024 six-months-old carp were furnished to eighty-one applicants and 733 two-year-olds to thirty-eight applicants in Virginia and Tennessee, and 500 planted in streams in Augusta County, Virginia.

Gold Fish.

The total production of this species for the year was 10,000, which were released in rearing ponds at the station. During the fall of 1887 388 gold fish were furnished to seventy-eight applicants in Virginia, Maryland, Alabama, Tennessee, North Carolina, Mississippi, Louisiana, Georgia, and Texas.

Through the courtesy of the management of the Norfolk and Western Railroad Company, the hatchery is now regarded as a flag station for all local freight trains.

FORT WASHINGTON STATION, MARYLAND.

This station was in charge of Mr. S. G. Worth and was operated under about the same general conditions as in the previous year, and the result of the season's work exceeded the most successful preceding season by 21,000,000 eggs, being the largest ever known there.

The hatchery building being very small, it was supplemented early in the season by a 14-foot army hospital tent adjoining, and used for storing needed apparatus and material.

An important feature was the successful operation of the automatic hatching jars with their tops off. The manipulation proved easy and advantageous, as very nearly all the eggs were transferred to Central Station, Washington, before the hatching period was reached. In 1887 there were seven expert spawntakers, while this season there were six and two apprentices, and the increased volume of work was probably due to a more complete organization. New territory was covered in the direction of Alexandria, and a considerable number of eggs were secured in the vicinity of Fort Foote.

The eggs were kept in the jars thirty-six hours before being shipped to Central Station, the line of the young shad being perfectly plain to the naked eye. Daily shipments were made, and, as usual, the eggs were placed on wire trays covered with cheap, loosely woven cotton cloth. The shipments of eggs to Washington during 41 days amounted to 70,249,000 eggs; during 22 days the shipments were 1,000,000 to 3,000,000 eggs daily, and were in charge of Capt. P. T. Yeatman.

The increase over the season of 1887 was more than 33 per cent. The launch *Blue Wing* was an important factor in the prosecution of the work, and her crew made a gain of about 7,000,000 eggs from the gill nets.

Operations began the second week of April and closed June 2, and in that time, the work having been entirely confined to shad, 81,177,000 eggs were taken.

BATTERY ISLAND STATION, MARYLAND, W. DE C. RAVENEL, SUPERINTENDENT.

SEASON OF 1887.

The season opened May 1. Some eggs were taken prior to this date, but owing to the low temperature of the water the development was not normal, and but a small percentage hatched.

Owing to dissatisfaction on the part of the fishermen, the large seine attached to the station was not operated during the season. It was deemed good policy to rely upon the fishermen for our supply of eggs, and the result justified the expectation.

The steamers *Fish Hawk* and *Halcyon* were assigned to work in co operation with the station, and contributed materially to the large results obtained.

On May the 2d the *Fish Hawk* anchored off Bull Mountain, in easy reach of the seines and gillers, where she remained, conducting operations independently, and transferring eggs to the shore station when the collections exceeded the capacity of her hatching apparatus, 1,330,000 eggs being so transferred.

The *Halcyon* worked in connection with the station, making daily trips to the fishing grounds, and transferring the eggs collected to the shore station; 8,402,000 eggs were thus collected. The services of this steamer were also utilized in transferring fry to the Chester, Elk, and Sassafras rivers, the total number transferred aggregating 3,000,000.

The percentage of ripe shad was unusually large this season. On the night of May 7, 4,000,000 eggs were taken, and a much larger number might have been obtained had it been practicable to visit all the nets.

The total number of eggs received at the station during the season was 60,569,000. 918,000 eggs were transferred to car No. 3, and 42,712,000 fry hatched at the station. Of these, 11,850,000 were placed in waters adjacent to the station and 29,882,000 distributed to other waters, as shown by the tables of distribution in the appendix.

SEASON OF 1888.

A programme for the conduct of the shad hatching on the Susquehanna for the season was submitted by Mr. Ravenel, the superintendent, about March 1. The same was approved and an allotment of money made for this work. The work of preparation was commenced immediately.

During the previous season it had been shown that the hatching facilities at the station were inadequate and the apparatus employed cumbrous and unsatisfactory. Automatic hatching jars were substituted for the cones, and a new building, 60 by 30 feet, was equipped with the new jars. A supplementary station was also established at Havre de Grace, equipped with one hundred jars, and having a capacity of ten million eggs at one time, doing away with the risk and inconvenience of transferring fry intended for shipment to distant waters from the station at Battery Island. Few good eggs were obtained prior to April 23. One week afterwards 25,000,000 good eggs had been taken. The station closed June 4, with a total production of 105,315,000 eggs. Of these, 17,400,000 partially developed eggs were transferred to cars Nos. 2 and 3. The remainder yielded 62,641,000 fry, which were distributed as shown in the tables in appendix.

The results this season are far in excess of any previous year, and this in the face of most unfavorable weather during the height of the season.

WASHINGTON CARP PONDS.

The demand for German carp continues from many States, and much interest is manifested in this species. Dr. R. Hessel is in immediate charge of the ponds, which have been under his care for a number of years. The surface area of the series of ponds amounted to a total of 23.50 acres.

The east pond, known as Babcock's Lake, was filled in, in order to strengthen the foundations of the Washington Monument, work being commenced on it about April 1, 1888. By the filling of this pond the Commission suffered a loss of $6\frac{1}{2}$ acres of the above water area, which necessitated the construction of a new pond, and it was determined to establish it near the office on the north side of B street, where there was already a pool, requiring but little excavation, except what was needed to remove a dense growth of vegetation. A 12-inch valve was placed in position to regulate the inflow of water which comes from the foot of Observatory Hill. This pond has a surface area of about 3 acres.

In October, 1887, the regular drawing off of the ponds began, and by December 31 the product of the several ponds was ascertained to be 235,687 German carp, 6,100 Japanese goldfish, and 1,500 tench.

About June 10 Superintendent Hessel had artificial spawning beds prepared for the carp in small ponds, and the ova, after the fish had deposited them, were transferred to large tanks, the result of which was the production of 600,000 fry. Five hundred thousand of these were shipped to the Wytheville, Virginia, Station, and 100,000 were liberated in Aquia Creek, a tributary of the Potomac River.

About the 1st of May, 1888, a large number of shad fry were transferred from Central Station to the West Pond, which is connected with the Potomac, and separated from it by a water gate, where they would not be disturbed by other fish or destructive animals during the natural period of their river life. It was ascertained by observation and by measurement that the young shad grew rapidly until towards the middle of August, when the growth was noticed to be slower; a month later it almost ceased, and from that time on no growth at all was observed.

On October 27 the sluice of the pond containing the fish was opened and about 800,000 young shad, which had attained a growth of from $2\frac{1}{2}$ to 3 inches in a pond of $6\frac{3}{4}$ acres, were liberated and started on their way to the sea.

CENTRAL STATION, WASHINGTON, D. C.

The work of this station is more general in its nature than that of any other station of the Commission. It includes the hatching of the eggs of *Salmonidæ*, including whitefish, intended for eastern waters; the distribution of fishes of the carp family, bred at the carp ponds, near the Washington Monument, and of fishes of the Mississippi Valley, transferred to eastern waters.

In connection with Fort Washington as an auxiliary station, it is the great hatching and distributing station for Potomac River shad.

It is also a central point for repair and equipment of the vessels of the Commission, and fish cultural and scientific equipment.

It is the aim of the Commission to constitute it also, as rapidly as circumstances will allow, a point for experiment, development, and illustration of the methods of fish culture and of scientific inquiry. This will include the development of aquaria, experimental ponds, etc., as a means of observation and determination of the habits and life histories of fishes, as also models of fish-cultural apparatus, both historical and representative.

During the earlier part of the fiscal year, all work appertaining to the receipt, shipment, and hatching of fry was in charge of Mr. William F. Page; the custody of the property of the station and shipment of carp devolving on Mr. J. E. Brown.

The Commissioner upon assuming office found a partial reorganization necessary, and Mr. William P. Seal was appointed superintendent.

The necessity imposed by Congress of making an exhibit at the Ohio Valley Centennial Exposition, held at Cincinnati, Ohio, compelled the transfer of Mr. Seal to that point to establish and operate an exhibit of aquaria as a part of the general exhibit of the Commission, under the charge of Capt. J. W. Collins, chief of the fisheries division, and Mr. S. G. Worth was made superintendent of Central Station.

The operations of the station are shown in the tabulated statements, which, with the exception of the shad, were prepared by Mr. Page, that of shad having been prepared by Mr. Seal. During the present fiscal year adult fish and fry and eggs, as follows, have been distributed through Central Station: German carp, 225,070; goldfish, 10,037; rock bass, 960; tench, 2,175; rainbow trout, yearlings and adults, 5,026, fry, 20,000; brook trout, adults and yearlings, 2,989, fry, 20,000; lake trout, 20,000; shad fry, 39,664,000; shad eggs, 13,351,000; whitefish eggs, 2,912,000; rainbow trout eggs, 57,632; besides several other kinds of fish in small numbers.

COLD SPRING HARBOR STATION, NEW YORK, FRED MATHER, SUPERINTENDENT.

This station is leased and operated by the New York State Fish Commission, through whose courtesy operations in the hatching and planting of salmon, whitefish, shad, and several varieties of the trout, etc., are conducted each season by the U. S. Fish Commission, under the immediate direction of Mr. Fred Mather, superintendent. During the past year a new hatchery, with complete hatching equipment and increased facilities for efficient work, was constructed by the New York commission, at a cost of about $5,000.

Atlantic Salmon.

In January, 1888, 500,000 eggs of this species were received from Bucksport, Maine, only 300 being dead on arrival. Losses in incuba-

tion, and otherwise, reduced this number to 459,000 fry, of which 439,000 were planted in the tributaries of the Hudson River, and 20,000 on Long Island. There seems to be no doubt of the suitability of these waters for the salmon, and with proper protection, by the enforcement of the State laws now in effect, the success and increase of this species in the waters of the Hudson is assured.

Sälbling.

Twenty-five thousand eggs of this species, in two lots, were received at the station during January and March, 1888, from Herr von dem Borne, Berneuchen, Germany, 10,000 being dead on arrival. Three thousand good eggs were shipped to Mr. E. B. Hodge, commissioner of fisheries, Plymouth, New Hampshire, and 3,000 to the U. S. Fish Commission station at Northville, Michigan. The balance, which were retained at the station, owing to heavy mortality in the eggs and fry, proved almost a total loss; only a small number of fry having been forwarded to the New York hatchery, at Caledonia, New York.

Whitefish.

On March 22, 1888, 1,000,000 whitefish eggs were received from the Northville Station, Michigan. Of this number, 50,000 were lost in incubation, and 150,000 fry escaped into the trout ponds at the station. The remainder, 800,000 fry, were planted in lakes on Long Island, New York.

Lake Trout.

One case containing 90,000 eggs of this species was received on December 28, 1887, from Northville Station, Michigan. The losses during incubation and afterward reduced this number to 85,200 fry, which were planted in lakes in Sullivan, Putnam, Queens, and Warren Counties, in the State of New York.

Brown Trout.

Very satisfactory results have been obtained from the planting of this fish. During the past season two lots of eggs of this species were received from Herr von Behr, of Schmoldow, Germany, and Herr von dem Borne, of Berneuchen, Germany. These were divided equally among the State commissions of New York, Wisconsin, Michigan, Virginia, and Minnesota; 19,000 eggs being forwarded to each. From the allotment to Cold Spring Harbor and 40,000 eggs taken from brood fish at the station, 55,500 fry were produced. One thousand five hundred of these were reserved at the station and the remainder deposited in streams, lakes, etc., in New York State.

Land-Locked Salmon.

In March, 1888, 35,000 eggs of this fish were received from the Grand Lake Stream Station, Maine. The loss in transfer and hatching subsequently amounted to only 1,000, leaving 34,000 fry, which were distributed to lakes and other waters in New York and New Jersey.

Rainbow Trout.

Two lots of eggs of this species were received during the month of March, 1888, from Baird Station, California, 24,000 in all being good on arrival. From this number, in addition to 1,000 eggs taken at the station, 23,500 fry were produced, which were distributed to applicants and deposited in suitable waters in New York State; none of the fry being retained at the hatchery.

Shad.

During the spring of 1888 the experiment was made of shipping shad eggs by express, 5,000,000 having been forwarded in this manner to the Cold Spring Harbor Station. The eggs reached destination in good condition, but the losses in incubation were considerable, only 350,000 fry being produced, which were deposited in the Hudson River at Albany, New York. The mortality in hatching was no doubt attributable to the use of a new pine supply pipe, and not to bad or unhealthy eggs, which were found to be in very good condition on arrival.

NEOSHO STATION.

During the summer of 1887, Mr. Marshall McDonald, acting under instructions from Prof. S. F. Baird, Commissioner, made an exploration of the Ozark region of southwest Missouri, with the object of ascertaining a suitable site for a fish-cultural station, where the propagation of species of fish suited to the streams of Missouri, Arkansas, and Kansas, could be conducted to advantage, and thus adequate provision made for a section of the country too remote from the existing stations of the Commission to be supplied to advantage from them. Mr. McDonald, after completing the investigation, submitted a report to the Acting Commissioner, Dr. J. H. Kidder, recommending the selection of a site in the suburbs of Neosho, Missouri, for reasons fully set forth in the report.

On December 21, 1887, the United States Senate, by resolution, directed the Commissioner of Fisheries "To report to the Senate at as early a day as practicable what measures, if any, had been taken for the selection of a site for, and the location of, a fish-cultural station of the U. S. Fish Commission in the Ozark region of southwest Missouri, with the views and recommendations of the Commissioner and the cost thereof." To this resolution the Acting Commissioner, under date of January 4, 1888, replied as follows, transmitting at the same time a copy of Mr. McDonald's report:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C. January 4, 1888.

SIR: In compliance with a resolution of the Senate, agreed to on the 21st December, 1887 (a copy of which is appended hereto), I have the honor to report that the availability of the Ozark region in southwestern Missouri for a fish-cultural station was made the subject of a personal investigation last summer by Mr. Marshall McDonald, under instructions from the late Commissioner Baird, modified and extended by Acting Commissioner T. B. Ferguson.

It appears from Mr. McDonald's report of his investigation that the neighborhood of the city of Neosho, in Newton County, Missouri, affords more favorable conditions than any other of the localities examined; and, furthermore, that the Neosho City authorities have guarantied to the United States the free use of some 17 acres of land and of a plentiful supply of excellent water for the purpose above named.

Should it be the pleasure of Congress to direct the establishment of a station for fish culture in this locality, the probable cost is estimated to be as follows:

Construction of buildings, ponds, and appliances	$8,000
Maintenance for fiscal year beginning July 1, 1888	5,000
Total	13,000

Very respectfully, your obedient servant,

J. H. KIDDER,
Acting Commissioner.

Hon. JOHN J. INGALLS,
President pro tempore United States Senate.

IN THE SENATE OF THE UNITED STATES,
December 21, 1887.

Resolved, That the Fish Commission is hereby directed to report to the Senate at as early a day as practicable what measures, if any, have been taken for the selection of a site for, and the location of, a fish-cultural station of the U. S. Fish Commission in the Ozark region of southwest Missouri, with the views and recommendations of the Commission and the probable cost thereof.

Attest:

ANSON G. MCCOOK,
Secretary.

[Extract.]

Report in reference to the establishment of a fish-cultural station of the U. S. Fish Commission in southwest Missouri, by Marshall McDonald.

The object of a station in the Ozark region is to make adequate provision for stocking the waters of Missouri, Kansas, Arkansas, Texas, New Mexico, Arizona, Louisiana, and West Tennessee with the species of food-fishes adapted to the natural conditions afforded by the waters.

Only a limited area of the extensive section of country under consideration affords waters suitable for acclimation of the trout or other salmonidæ.

Climatal conditions would largely restrict the work of the proposed station to the pond culture of the tench, bass, rock bass, carp, and other species, native or introduced, which are adapted to the warmer waters of this section, and the distribution of the same in very large numbers to the streams, lakes, and ponds of the Southwest.

The necessary conditions to be fulfilled in the establishment of such a station are as follows:

(1) The location should be central, with reference to the section in the interest of which the station is to be operated.

(2) It should be in convenient communication by railroad with all portions of the area over which its operations are to extend.

(3) The water supply for ponds and hatching houses should be practically unlimited, so that there should be no restriction in the free use of water in the most extensive work that it might be expedient to undertake.

(4) The water should be spring water, remaining clear and of even temperature under all circumstances of weather or season, and with such head or fall as to permit a gravity supply to hatchery and ponds; thus eliminating one serious element in the cost of operating a station where circumstances render it necessary to lift the water by pumping.

The conditions thus imposed limited the location to some point in the Ozark Hills, a region abounding in magnificent springs, forming the headwaters of clear streams, which on the one side flow into the Missouri River and on the other into the Arkansas. It is, moreover, traversed through its entire extent from northeast to southwest by the Frisco road, which, with it connections, puts this section into convenient communication with all parts of the Southwest which would draw their supplies of fish from the proposed station.

An exhaustive examination was made of all localities which offered reasonable promise of affording the requisite facilities for a station. Springs affording unlimited supply of water were numerous. Some were excluded by reason of inaccessibility; others, presenting the advantages of convenient location and abundant water supply, were excluded on account of the difficulty or impracticability of controlling the water supply so as to secure sufficient head or fall of water to utilize it for the supply of ponds and hatchery.

The choice of locations was finally restricted to four, viz: The Percy Cave Spring, in the vicinity of Springfield, Missouri; the Jones Spring, immediately on the Gulf road, 4 miles south of Springfield; the Mammoth Springs, Arkansas, just south of the Missouri line, and immediately on the line of railroad leading from Springfield to Memphis, Tennessee, and the magnificent group of springs in the immediate vicinity of Neosho City, Missouri.

The springs in the vicinity of Springfield impressed me most favorably, but careful examination made it evident that the water supply was entirely inadequate to afford the amount required to feed the extensive system of ponds that will be required in the development of the station.

The choice of location lies, therefore, between Mammoth Springs, Arkansas, and the site offered by the city of Neosho. Both stations furnish unlimited water supply, capable of easy control and utilization. Each is advantageously situated, immediately on a line of railroad, and thus affords equal convenience and facilities for distribution. In either case the site for buildings and ponds and the necessary water franchise will be donated to the United States Government free of charge.

The location at Neosho, however, presents the following important advantages:

It is more centrally situated with reference to those sections to which the distribution of fish is to be made, and the station can therefore be more economically operated than the one at Mammoth Springs. The amount of land available for ponds is ample, and lies conveniently for their construction at a moderate expenditure of labor and money.

The ground available for this purpose at the Mammoth Springs location is very limited and lies so unfavorably, that the construction of the series of ponds required can be accomplished only under considerable difficulty and at a very considerable expenditure of money. Indeed, in my judgment it will be impracticable at the Mammoth Springs location by any reasonable expenditure to secure the development of ponds necessary to carry on pond culture on the scale it will be necessary to conduct the operation of the station. For these reasons I respectfully recommend the selection of the site proposed to be donated to the United States Government by the city of Neosho.

Seeking to influence the selection of location by the manifestation of a liberal spirit, the corporate authorities have already voluntarily executed an agreement to convey to the United States Government title to 17 acres of land within the corporate limits of the city, and having upon it a magnificent spring flowing nearly 600 gallons per minute. This supply is ample for all needs, immediate or prospective; but they further agree, if the supply is not ample for all purposes, to guaranty to the United States the franchise of another spring flowing several hundred gallons of water per minute, and to convey it to the ponds and hatchery without charge to the U. S. Fish Commission. We could hardly ask or desire more liberal concessions than have been voluntarily tendered, nor can we probably find another location so advantageously situated for convenient and economical work.

The agreement of the mayor and city council, properly executed and attested, is herewith submitted; also a plat of the tract of land which it is proposed to convey to the use of the U. S. Fish Commission.

The appropriation requisite for the erection of a new station must be specifically made by Congress; and no steps looking to its occupation can properly be undertaken in advance of such action. But assuming from the obvious necessity and importance of such a station in the development of the work of the Commission, and from the active and general interest that the mere suggestion has awakened, that the matter will be brought to the attention of Congress at an early date, I respectfully submit the following estimates of the cost of erecting and operating the station, as follows:

For the construction of hatchery, quarters, inclosures, and ponds	$8,000
For the conduct of the station for the fiscal year beginning July 1, 1888, salaries, temporary services, maintenance, repairs, etc	5,000

As there is no period of the year in which outside building operations may not be carried on, it is desirable that the appropriation for construction may be made immediately available, the buildings and a sufficent number of ponds for immediate use may be completed early in the summer of 1888, and the station fully equipped for extensive work without any material delay.

M. McDONALD,
In charge of Fish Culture.

On June 9, 1888, the Secretary of the Treasury transmitted to Congress an estimate from the U. S. Commissioner of Fisheries of an appropriation for the establishment and maintenance of a fish-cultural station in the Ozark region of Missouri, as follows:

TREASURY DEPARTMENT, *June* 9, 1888.

SIR: I have the honor to transmit herewith, for the consideration of Congress, copy of a communication from the U. S. Commissioner of Fish and Fisheries of the 8th instant, submitting an estimate for an appropriation of $13,000 for the establishment and maintenance of a fish-cultural station in the Ozark region, in southwest Missouri.

Respectfully yours,
C. S. FAIRCHILD,
Secretary.

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., June 8, 1888.

SIR: I have the honor to request that you will transmit to Congress, for consideration by the Committee on Appropriations, an estimate for appropriation for the establishment and maintenance of a fish cultural station of the U. S. Fish Commission in the Ozark region, in southwest Missouri, as follows:

Construction of buildings, ponds, and appliances	$8,000
Maintenance for fiscal year beginning July 1, 1888	5,000
	13,000

The necessary explanations to accompany estimate are embraced in Senate Miscellaneous Document No. 23, copy of which is respectfully transmitted.

Very respectfully,
M. McDONALD,
Commissioner.

The estimate thus transmitted was provided for in the sundry civil bill, which was pending at the close of the fiscal year 1888.

DULUTH STATION.

Legislation looking to the establishment of a station for hatching whitefish and lake trout in the vicinity of Duluth, Minnesota, was initiated by a petition from the fishermen of Lake Superior, who had "formed themselves into an association to promote their mutual interests, their aims and objects being a better understanding of the fishing laws of the several States, a uniform action among the fishermen concerning the regulation of the size of meshes of all nets, and the enforcement of the laws concerning them, and to secure the artificial propagation of the eggs of both whitefish and lake trout by a fish hatchery." They further pledged themselves to aid, both by their labor and by the use of their fishing plants and men, the work of collecting eggs for propagation. This petition was accompanied by assurances that if the necessary appropriation for the establishment of a hatchery should be made, the people would donate a suitable site with an ample supply of good water.

The petition was forwarded to the Hon. Knute Nelson, Representative from the district in which the city of Duluth is situated, who, after conference with the Commissioner, brought the matter to the attention of the Committee on Appropriations, and secured the introduction of an item into the sundry civil bill appropriating $10,000 "For the establishment of a fish hatchery on Lake Superior at or near Duluth, Minnesota: *Provided*, That the city of Duluth shall furnish without charge a suitable site for said hatchery." This bill became a law August 4, 1886.

Of the several sites available, that offered by the Lakeside Land Company on the Lester River, in the northern suburbs of the city, was after examination found most desirable, and was accepted. The site thus conveyed to the United States in fee simple contains about 6 acres lying on the shore of Lake Superior and bounded on the north by Lester River. In addition to the donation of land for the station, the Lakeside Land Company made a cash contribution of $1,000 towards the expense of introducing a supply of water by gravity from Lester River.

Jurisdiction over the land was ceded to the United States by act of the State legislature, approved March 2, 1887. The validity of title in the lands thus conveyed was duly certified by the Attorney-General on March 10, 1888.

In November, 1887, after personal examination of the ground by the assistant in charge of fish culture, the location of the hatchery building was definitely marked out, and the general plans for the development of the station indicated. Plans and specifications for the hatchery building and for the steam and water distributing plant were prepared during the winter and following spring, and, after due advertisement, the building let to contract on May 21, 1888. Work was in satisfactory progress at the close of the fiscal year, and it is expected to have the station completed and equipped for work the ensuing winter.

Steamer Fish Hawk.

SEASON OF 1888.

Previous to leaving for the Delaware River, the steamer *Fish Hawk*, commanded by mate James A. Smith, U. S. Navy, was supplied at Baltimore, Maryland, with additional hatching apparatus; two hatching tables were placed on each side of the hatching deck, with a capacity of thirty-seven McDonald automatic jars each, the water supply being furnished by two good-sized wooden tanks, placed on the upper deck; the hatching facilities were thus increased so that about 12,000,000 eggs could be under process of hatching at one time.

Spawn was secured from five haul seines, operated on the New Jersey side of the river below Gloucester City, and from gillers near by. The first eggs were taken May 7, and operations continued until June 5, when orders were received to cease collecting spawn; 48,607,000 shad eggs were collected, of which 1,800,000 were delivered to the New York Fish Commission, 4,397,000 to the Delaware Fish Commission, and 2,139,000 were forwarded to Utah, and hatched en route, on Fish Commission car No. 2, which is equipped with the McDonald closed jar, it being the only hatching jar that can be used on this car, which may be called a traveling hatching station.

Thanks are due the Pennsylvania State Fish Commission for the assistance rendered in transporting fry by messenger to the upper stretches of the Delaware, where the numerous beautiful pools afford protection to the young shad during the period of their river life. Sixteen million eleven thousand fry were deposited in the upper waters of this river, and 14,840,000 were liberated in the vicinity of Gloucester City, New Jersey.

It is worthy of mention here that during the evening of May 29 a violent thunderstorm occurred, lasting from 6 o'clock until midnight. The hatching jars at this time contained 4,481,000 eggs, in apparently excellent condition, with the embryo shad well formed and plainly visible with a glass, scarcely any dead or unfertilized eggs being in the jars. About 8 p. m. it was observed that the majority of the eggs were rapidly turning white. In some jars as many as one-half were dead. There being no perceptible change in the condition of the water, it is reasonable to suppose that the loss, amounting to 1,918,000 eggs, was due to the water being thoroughly charged with electricity, caused by the violent electrical disturbance taking place at the time.

On June 4 William Johnson took from one shad a pan of eggs, which, when placed in a jar, and carefully measured, was found to contain 115,000.

NOTES ON THE SPECIES PROPAGATED AND DISTRIBUTED.

The Sole (*Solea solea*).

May 16, 1888, sixteen English sole were received from Mr. E. G. Blackford, and June 2 twenty more. Thirty-four survived and were fed daily with clams, etc., at the Wood's Holl Station. Mr. Blackford obtained the soles from Mr. Thomas J. Moore, curator of the Free Public Museum, Liverpool, England.

The Flatfish or Winter Flounder (*Pseudopleuronectes americanus*).

This species was found in breeding condition at Wood's Holl, Massachusetts, early in February. The eggs were extremely adhesive, and had a tendency to form in large lumps. They were hatched by spreading them thinly on panes of glass, and placing them in an aquarium of running water. 1,179,000 eggs were taken, and produced 320,000 fish, of which 220,000 were planted in Vineyard Sound.

The Cod (*Gadus morrhua.*)

Spawning cod were procured for the Wood's Holl Station from Nantucket Shoals and Noman's Land; 155 fish were brought from Noman's Land November 14, and 62 fish from the same place November 17. 783 fish arrived from Nantucket Shoals November 17.

From these were obtained all the eggs that were impregnated at the station. Eggs were taken from November 17, 1887, until February 4, 1888. The eggs were stripped into large pans with a moderate allowance of water and milted without much loss of time. They were thoroughly stirred immediately after adding the milt and carried to the hatchery. 30,088,000 eggs were obtained, from which 7,822,000 fry were hatched. The average percentage of production was 26 per cent., and the highest 92½ per cent.

The efforts to transfer the eggs from Gloucester to Wood's Holl were unsatisfactory. For an account of the experiments leading up to the successful hatching of cod at the Gloucester Station see the description of this establishment.

The greatest number of eggs taken in any one day during the season was on January 14, when 7,056,000 were collected.

There is very little variation in the size of cod eggs taken in various places, and from several sizes of fish.

Mr. Robinson finds that 1 gallon of water per minute is exactly the amount that should pass through each cod-hatching box in order to make the siphon work properly; if less goes through the siphon will fail to catch promptly, and if more is used it will not break for some time.

His best results from the tidal hatching box were obtained with the eggs three layers deep, or 350,000 to the box. The jar seems to be objectionable for cod eggs because of lack of aëration. Eggs of the same age in boxes and jars will hatch out at different times. The box will develop them from five to eight days earlier than the jars.

Mr. Robinson has noticed that eggs handled in the ordinary way, and with water of the usual winter temperature, are most delicate between the sixteenth and twentieth days. They are then adhesive and will stick to the sides of the box when the tide begins to ebb, unless one is very careful to keep the sides thoroughly wiped off two or three times a day. Early in the season, when the water is warmer, the eggs become adhesive at the age of five or six days and must be brushed off the sides and lower edge of the jar with a feather.

The slow tidal motion of the box was found to be entirely suitable for the care of the young. When the temperature of the water fell to 30° all the spawning fish died.

The Haddock (*Melanogrammus æglefinus*).

Not much success was achieved in hatching haddock eggs. Mr. Robinson found them to be larger than those of the cod, and to have a beautiful pinkish color. They measure sixteen eggs to the inch, while the cod measure eighteen.

One lot of haddock eggs taken after the middle of March contained only fifteen and a half to the inch. There are 100,000 fewer eggs in a quart of the haddock than of the cod. A quart of cod eggs number 336,798, and a quart of haddock eggs 236,556.

Haddock eggs are more tender than any other eggs that Mr. Robinson has yet handled. Often on the fourth or fifth day the eggs would all die, with scarcely any loss up to that time. They will float in water which is less dense than that suitable for cod. All the eggs of this species were taken in water of a density of 23½ except 75,000. After the weather seemed to be settled and the water in the tank rose above 33°, the density of the water changed from 27 to 25 and 24½, and as low as 23. This change took place on or about April 1, and interfered greatly with the success of the hatching operations.

Floating eggs.—250,000 floating eggs of undetermined species were brought in the *Grampus* hatching bucket and in pans from Narragansett Bay to Wood's Holl in June, 1888, by Dr. Bean. 150,000 of these were hatched and planted and embryos kept for identification.

The Tautog (*Hiatula onitis*).

The Mackerel (*Scomber scombrus*).

The Scup (*Stenotomus chrysops*).

Fair results were obtained at the Wood's Holl Station in hatching eggs of the last three species, and when it becomes necessary to apply artificial methods to their reproduction the work can be successfully prosecuted.

The Red-eye Perch or Rock Bass (*Ambloplites rupestris*).

6,628 adult fish of this species were collected in the vicinity of Wytheville, for distribution to ponds in Virginia and elsewhere. On March 1, 1887, 20 small individuals were sent to Herr Max von dem Borne, of Berneuchen, Germany. A new station was provided for in 1888, at Neosho, Missouri, for the cultivation of this and allied species for introduction into waters of the Southwest.

The Crappies (*Pomoxys annularis* and *sparoides*).

A new station at Neosho, Missouri, was projected in 1888 for the cultivation of crappies, rock bass, black bass, and tench for waters of the Southwestern States.

The Black Bass (*Micropterus salmoides*).

Yearling fish of this species have been obtained at the Wytheville Station for distribution to applicants and streams, chiefly in Virginia.

A new station was provided for in 1888 at Neosho, Missouri, for the cultivation of black bass and allied species suitable for the streams, lakes, and ponds of the Southwest.

The Sea Bass (*Centropristis nigricans*).

Fair results were obtained at the Wood's Holl station in hatching eggs of this species, and the conditions of its successful incubation were established. Should artificial methods become desirable they can be efficiently applied to the multiplication of this fish.

The White Perch (*Roccus americanus*).

On the 1st of March, 1887, sixteen yearlings of this species were sent from Cold Spring Harbor, New York, to Herr Max von dem Borne, Berneuchen, Germany. Only three of them reached him alive.

The Whitefish (*Coregonus clupeiformis*).

A detailed account of the work with this species is given under the description of the Michigan Stations. 15,000,000 eggs have been shipped to the Pennsylvania fish commission, 10,000,000 to the Minnesota commission, and 1,000,000 to the New York commission. The work in Michigan will hereafter be limited to the Alpena Station.

The first eggs were received from Alpena November 28. Shipments were made during the months of December, January, February, and March. The use of creek water made the season for shipment much longer than formerly. The fry resulting from the allotment to the New York commission were planted in Long Island lakes.

At the close of the fiscal year ending June 30, 1888, work was in progress upon a new station at Duluth, for the propagation of this species.

Whitefish eggs were forwarded to the National Fish Cultural Association, London, to Herr Von Behr, Germany, and to New Zealand. The number sent to London was 45,000.

The European Grayling (*Thymallus thymallus.*)

The New York Fish Commission received 10,000 eggs of the grayling from France in 1887, of which only 300 were good. A few of these were hatched at Cold Spring Harbor, but did not live.

The California Salmon (*Oncorhynchus chouicha.*)

The McCloud River Station, which was not operated from 1883 to 1888, was prepared in the spring of 1888 for work during the approaching season. The necessity of continuing artificial propagation to keep up the salmon fisheries of the McCloud was so evident that steps were

taken to resume the work. Provision was made in 1887 for salmon hatching on the Columbia River, and Mr. Stone was directed to establish a station somewhere on this river or its tributaries. A site was chosen on the Clackamas, and arrangements made for beginning work the ensuing season. Applications have been received up to the present time for several million salmon eggs, from parties on the small coast rivers, who offered to receive and hatch the eggs and distribute the young fish at their own expense.

The Atlantic Salmon (*Salmo salar*).

Eggs of this species are collected and hatched at the Bucksport Station. From there consignments are forwarded to various State commissions who have contributed to the expense of handling them. At this station the plan of rearing salmon until they have reached a length of several inches before turning them out was begun in 1888. See under the Maine Stations for fuller details.

At Craig's Brook there was a great loss of salmon during the summer, probably on account of the low stage of the water. The temperature of the water became high, and on the morning of July 5 an extreme of 72° F. was recorded.

The spawning season began October 25 and ended November 5; 1,184,000 eggs were taken. The average number of eggs per female was 8,691.

The loss up to the final shipment was 7.1 per cent. The average temperature in November, 1887, was 42.3°; in December, 34.8°. In January, 1888, 33.5°; February, 34.5°.

500,000 eggs of this species were received at the Cold Spring Harbor Station, from Bucksport, Maine, and nearly all of them were planted as fry in the Hudson River and Long Island waters. During the months of May and June, of 1888, salmon were caught in the Hudson by shad fishermen. Commissioners Blackford and Burden estimated that over 300 adult salmon were taken from the river between Gravesend Bay and the dam at Troy.

The Landlocked Salmon (*Salmo salar* var. *sebago*).

An account of the number of eggs of this species taken, and their distribution, will be found under the heading of the Maine Stations.

The salmon made their appearance at Grand Lake Stream early in September, 1887. A trap inclosing several acres of water, of a maximum depth of 20 feet, was made to retain salmon. October 25, the inclosed fish were found to have begun to form ridds. The first eggs were taken October 26. The inclosure was cut several times by muskrats. The total catch of salmon was 154 in excess of that of 1886. The heaviest fish taken was a female weighing 5 pounds 7 ounces; this was caught November 13. In 1887 only one marked fish was seen, and that appeared to have been marked in 1885; none of the fish marked in 1886 were observed.

The cost of fertilized eggs at this station was a little less than 1 cent for four eggs.

The eggs were kept in the hatchery from February 27 until April 2, before they were shipped.

35,000 eggs were received from Grand Lake Stream at the Cold Spring Harbor Station. The fry were deposited in the waters of New York and New Jersey. Eggs of this species were received from Grand Lake Stream, Maine, at the Wytheville Station, where they were hatched and the fry deposited in the Shenandoah River, Virginia.

90,000 eggs were sent to foreign countries in 1887 and 60,000 in 1888; their distribution is recorded elsewhere.

The Rainbow Trout (*Salmo irideus*).

Rainbow trout are reared at Baird Station, California, and also at Northville, Michigan, and Wytheville, Virginia, and by various State commissions. The spawning season of this species at Baird usually closes about May 1, but in 1888 some females continued spawning until the end of May. Eggs were taken from January 1 to April 26, and some large trout continued spawning through May. 468 trout yielded 443,500 eggs, an average of 948 eggs each.

The best results obtained at Northville, Michigan, since the species was brought there, were secured during 1888. The egg-taking season lasted from December 8 to May 4. During the season 8,578 yearling fish were planted in open streams, lakes, and ponds, in Michigan, Missouri, Ohio, Indiana, Arkansas, Tennessee, and Kansas.

During the last fifteen days of the hatching period of the rainbow trout eggs, the loss is less than one-tenth of 1 per cent. The greatest number of eggs taken from a single female was 2,000. This species is very successfully bred at the Wytheville Station, which has become one of the most important distributing points for foreign as well as home applicants.

The prominent feature of the work at this station is the large distribution of yearlings, amounting, in 1888, to 18,618; besides these, 150 3-year-olds were liberated.

Eggs of the rainbow were received at Cold Spring Harbor in March, 1888, from Baird Station, California. These were hatched and distributed in New York waters. The rainbow trout are unsatisfactory breeders at Cold Spring Harbor. From 6 fish less than 2,000 eggs were taken; and of these about $\frac{2}{3}$ were impregnated, a larger proportion than usual. 80,000 eggs were shipped to foreign countries, in exchange, in 1887, and 78,000 in 1888. These are referred to in the tables.

The Brown Trout (*Salmo fario*).

This species was introduced at the Northville Station in 1883. The results obtained with the fry have not been satisfactory during the first 3 months of their lives; after that, the loss is insignificant.

In June of 1888, Mr. Dean caught from the creek, adjacent to the Northville hatchery, a brown trout 22 inches long, and weighing 4

pounds. The greatest number of eggs taken from a single female was 2,375.

Eggs of this species were received from Herr von Behr and Herr von dem Borne, of Germany, in 1888. These were distributed among New York, Wisconsin, Minnesota, Virginia, and Michigan commissions, 19,000 being sent to each of these States from Cold Spring Harbor. The receipts of eggs were as follows:

March 4, 1887, from Herr Max von dem Borne, per steamer *Elbe*	8,000
March 9, 1887, from Herr von Behr, per steamer *Werra*	50,000
March 22, 1887, from Herr Max von dem Borne	50,000
February 22, 1888, from Herr Max von dem Borne	50,000
February 29, 1888, from Herr von Behr	60,000

The Loch Leven Trout (*Salmo levenensis*).

The first Loch Leven trout hatched at Northville were produced in the spring of 1883. The species has proved hardy and well adapted for pond culture.

Further particulars may be learned from the account of the Michigan stations.

48,000 eggs were received, January 12, 1887, from Sir James G. Maitland, Howietoun, Scotland.

The Sälbling (*Salvelinus alpinus*).

25,000 eggs of the sälbling were received at Cold Spring Harbor during January and March of 1888 from Herr von dem Borne. Some of these were shipped to the New Hampshire Commission, some to the New York Commission, and the balance were sent to Northville, Michigan.

February 9, 1887, there were received from Herr Max von dem Borne 20,000 eggs, of which 8,000 were dead. March 9, 1887, 20,000 eggs were obtained from the same source; of these 5,500 were dead. On the same date 20,000 eggs were received from Herr von Behr.

The Brook Trout (*Salvelinus fontinalis*).

This species is reared at Northville, where the work has been very successful, as will be seen by referring to the account of the Michigan stations.

The season's work on brook trout outranks any previous season in the percentage of good eggs from a given number. The eggs were taken from October 13 to November 12.

The highest number of eggs taken from one female was 1,200, and the average number from 786 females was 348 eggs. This species is reared also at Wytheville. The first eggs obtained from the species at this station were secured in October, 1887. The distribution of yearlings from this station in 1888 very much exceeded that of any previous year, aggregating 10,735.

January 15, 1887, 10,000 eggs were shipped to the National Fish Cultural Association, London, England.

The Lake Trout (*Salvelinus namaycush*).

The eggs of this species were taken at Northville from October 15 to November 20. An account of their distribution appears under the discussion of the Michigan Stations.

A notable circumstance in the distribution of this species was a deposit, on December 16, 1887, of 500 two-year-olds in a lake in Alpena County, Michigan. The eggs, for the greater part, were taken in small numbers, very few fish being stripped at a time. This prolonged the spawning season to a greater length than in any preceding season.

90,000 eggs of the lake trout were received at Cold Spring Harbor, December 28, 1887, from Northville. The fry were planted in New York lakes.

The fry in the troughs were fed on the bellies of soft clams (*Mya arenaria*) and they all thrived on this food. The same material has proved suitable for the lake trout in the two attempts made to rear them. When the fry were large enough to eat coarser food they received boiled mussels (*Mytilus edulis*) chopped fine. In former years lake trout were kept until the middle of the summer, when they would gradually grow less in numbers, and by October would all be gone.

The lake trout is kept in rearing ponds at the Wytheville Station. At the close of the fiscal year ending June 30, 1888, work was in progress upon a new station at Duluth, Minnesota, for the propagation of this species.

The Shad (*Clupea sapidissima*).

One of the principal stations for hatching shad is at Fort Washington, Maryland, and details are given in the account of this station. An important departure was effected in the successful operation during 1888 of the automatic hatching jars with their tops off.

During forty-one days 81,177,000 eggs were taken. From the second week of April to June 2, 70,249,000 of these were shipped to Washington from Fort Washington.

At Fort Washington about two-fifths of the shad eggs were obtained from gill nets and three-fifths from seines.

Only 8 per cent. of the eggs taken at Fort Washington were gathered between midnight and noon in 1888; in 1887, 14 per cent., the average of the two seasons being 11 per cent. In 1887, at Fort Washington, the proportion of male to female shad was nearly 3 to 1. In 1888, it was about 2 to 1. The shrinkage from air exposure in shipping shad eggs from Fort Washington to Washington, in 1888, was about 10 per cent. In the season of 1888 the hatchery at Battery Island, near Havre de Grace, Maryland, was equipped with 386 automatic hatching jars and the use of cones was discontinued. 7,000,000 shad eggs were taken in one night, prior to May 1, at Havre de Grace.

A supplementary station was established at Havre de Grace, with a capacity of 10,000,000 eggs at one time. The total production of eggs up to June 4 was 105,315,000.

At Battery Island Station, Maryland, eggs were obtained in 1887 from the fishermen. The steamers *Fish Hawk* and *Halcyon* coöperated with this station. The percentage of ripe shad at Battery Island was unusually large. 60,569,000 were received during the season of 1887. In the season of 1888 the steamer *Fish Hawk* was supplied with two hatching tables on each side of the hatching deck, with a capacity of 37 McDonald automatic jars each. The water supply was furnished by two wooden tanks placed on the upper deck. This increased the capacity of the steamer to the amount of 12,000,000 eggs at one time.

The first shad eggs were collected May 7 by the steamer *Fish Hawk*, in Delaware River near Gloucester. The last eggs were taken June 5. A single shad from Delaware River, on June 4, yielded 115,000 eggs. The temperature of the water did not exceed 65° until May 30, and, as a consequence, the period of incubation was retarded to 7 days.

On May 29, a violent thunderstorm on Delaware River destroyed 1,918,000 eggs which were nearly developed in the jars.

Three times during the season of 1888 heavy rains produced freshets in the Susquehanna, which ran off the fish for several days, and high winds prevailed throughout. The last freshet, occurring on May 31, practically closed the work, only 340,000 eggs having been taken in June. As soon as the water became clear fish were caught in abundance and continued plentiful until the end of the fishing season. The catch of shad was heavy, both in the bay and up the river, many gillers getting over 6,000 during the season.

The experiment of shipping shad eggs by express was tried in the spring of 1888; 5,000,000 were forwarded in good condition to Cold Spring Harbor, New York. There was great mortality in hatching these eggs in spring water at Cold Spring Harbor. This was attributed to the use of pine water pipes, which had not been thoroughly soaked. All the other eggs hatched remarkably well and shad have always hatched well in spring water before. 2,139,000 eggs were forwarded to Utah on car No. 2 and hatched on the way.

On May 15, 1887, a shipment of 1,184,000 eggs was placed in car No. 3 under the care of Mr. S. G. Worth for hatching on the way to Albany, New York. The eggs reached their destination on the 16th, and 30,000 were hatched on arrival. The remainder were hatched in the car by connecting the feed pipes with the city water works, the last of them having been liberated on the 18th. The loss in hatching was 20 per cent., due chiefly, in Mr. Worth's opinion, to the low temperature of the water in the engine tenders. The successful working of hatching apparatus on cars Nos. 2 and 3 enabled us to relieve the hatcheries of over 2,000,000 eggs per car each trip, the loss in transit being little greater than at the hatcheries.

The number of shad fry distributed from April 26 to June 9, the commencement and close of the season of 1888, was the largest since the organization of the Commission. The total number of eggs col-

lected was 235,099,000, of which there were lost during incubation at hatcheries and in transportation 81,208,700, the total number of fish and eggs distributed being 153,890,300. The number of eggs collected and of fish and eggs distributed by stations is shown in the tables of distribution in the appendix.

Summary by river basins of shad fry distributed during 1888.

River basin.	Total number shad deposited.
Tributaries of Narragansett Bay	1,764,000
Tributaries of North Atlantic coast	3,404,000
Hudson River and tributaries	4,040,000
Hudson River and tributaries, from eggs hatched at Cold Spring Harbor, New York	160,000
Delaware Bay and tributaries	34,159,000
Delaware Bay and tributaries, from eggs hatched at Wilmington, Delaware	3,560,800
Chesapeake Bay and tributaries	84,136,000
Tributaries of South Atlantic coast	3,921,500
Tributaries of Gulf of Mexico	16,820,000
Inland waters (Salt Lake, Utah)	1,925,000
Total	153,890,300

The Carp (*Cyprinus carpio*).

The pond area devoted to this species in the Washington carp ponds up to 1888 amounted to 23½ acres, but this was reduced to 17 acres by the filling of Babcock Lake. A new pond of 3 acres was established; 235,687 carp were collected during 1887, and in 1888, 600,000 fry were produced. Gravid carp were placed in the ponds May 15, 17, 18, and 19, 1888, water temperature 65° to 68°, increasing within a few days to 72° to 73°, when the fish began to deposit their eggs in great numbers upon the roots and lower branches of water plants. On the night of May 25, and subsequently, a sudden fall in temperature stopped the development of eggs, and killed many of them; the number of young fish hatched out decreased so greatly that it was necessary to restock the ponds. In breeding ponds of about 40 by 60 feet and 1½ feet deep it is easy to hatch out more young carp than the water will nourish. The pond may be completely filled with young carp, but within a few days thousands of them will perish by hunger for the want of natural food.

They will not take artificial food during the first three or four weeks, but live upon algæ and animalculæ. 6,000 carp were produced at the Wytheville Station and 440,000 fry were received during the summer of 1888 and released in the rearing ponds at Wytheville. The results were not very favorable. During the summer of 1887, water snakes killed a great many young carp in the west pond at Washington, District of Columbia; 40 fish were found in the stomach of a snake 3½ feet long. Mr. Hessel thinks the water snake one of the most destructive enemies of young fish.

On December 14, 1887, 5,000 carp were sent to the City of Mexico.

The Goldfish (*Carassius auratus*).

10,000 goldfish were hatched at Wytheville, and released in the rearing ponds. The account of the distribution is given in the sketch of the station.

The Tench (*Tinca tinca*).

This European species has been under cultivation in Washington, District of Columbia, for several years. In 1888 provision was made for rearing it at the new station of Neosho, Missouri, for introduction into the Southwestern States.

The Sturgeons (*Acipenser spp*).

June 11, the steamer *Fish Hawk* went to Delaware City, Delaware, to make some experiments with sturgeon spawn, with a view to determining what apparatus and conditions are necessary to hatch the eggs successfully. The vessel remained at this place until the end of the month, and during that time diligent search was daily made among the sturgeon fishing boats, to find fish suitable for the purpose, but not one could be found.

In May and June, 1888, Dr. John A. Ryder, professor of biology in the University of Pennsylvania, investigated the sturgeon of the Delaware River, and a monograph resulting from his studies will appear in the Bulletin for that year.

The Lobster (*Homarus americanus*).

Lobster eggs were collected from May 16 to May 31, 1888. None hatched until June 2, when they began to hatch rapidly.

When the lobsters were crowded in tubs in carrying them from Lobsterville in the launch, the time of the voyage being two hours, only a few of their eggs hatched; but when towed in the dory live-car the eggs nearly all hatched. 2,092,000 lobster eggs were collected at Wood's Holl, of which 193,000 were sent to the Pacific coast. An account of this transfer is given below.

TRANSPLANTING OF LOBSTERS TO THE PACIFIC COAST OF THE UNITED STATES.

The inhabitants of the Pacific coast have long desired to add the American lobster (*Homarus americanus*) to the food supply of their region, and they have from time to time urged the Government to attempt its transfer to the Pacific Ocean. The State of California has contributed to the accomplishment of this object, both independently and with the help of the U. S. Fish Commission.

The effect of the more equable temperature of the water and the interrelations of the indigenous fauna with the introduced lobster can be determined only by experience; but it is believed that the species will adapt itself to its new surroundings and prove a valuable addition to the already large stock of edible crustacea.

The first attempt to transfer the lobster was made in June, 1873, and was unsuccessful. The second shipment, in June, 1874, resulted in the

planting of only four lobsters out of one hundred and fifty, with which the messengers started.

In June, 1879, the third attempt was made under the supervision of Mr. L. Stone, and twenty-two lobsters were taken to the Pacific with the loss of a single individual. These were all females, and, although they carried a large number of eggs, it is not known that they accomplished the purpose of the transfer.

The determination of the best methods of shipping lobsters long distances overland has been a difficult problem, but was simplified by the introduction of cars built specially for transporting live fish. The experiments made by the late Capt. H. C. Chester at Wood's Holl, Massachusetts, in 1886, demonstrated the practicability of carrying them safely with a limited supply of sea water, at a low temperature, in a packing of rock weed (*Fucus*) and his methods were applied in the fourth trial in June, 1888, by Mr. J. F. Ellis, in charge of the Fish Commission Car No. 3, with the efficient help of Mr. R. S. Johnson, Mr. Trenholm, and Mr. John Jansen. This party left Wood's Holl, Massachusetts, June 14, 1888, with 614 lobsters, of which 360 were females, eight of them having eggs attached to their swimmerets. The length of the lobsters ranged from 8 inches to about 12 inches. 150,000 loose eggs, cut from the swimmerets, were carried in the ice box on twelve cloth-bottom trays, combined into one package, and sprinkled with salt water twice daily during the trip. The eight egg-bearing lobsters died on the way and 46,000 eggs were taken from them and added to the stock on the trays.

The lobsters were placed between layers of moist rock-weed in coverless wooden trays, with bottoms consisting of five or six narrow slats, the trays measuring 22 inches in length, 17 inches in width, 6 inches in depth, and holding about 6 lobsters each. These crates were placed in the fish-transportation tanks, or refrigerators, under the floor of the car. The temperature of the carrying tanks was controlled as far as possible by the use of ice. Coarse salt was provided in large quantity for making a freezing mixture with the ice and to make a brine for use upon the lobsters if the supply of sea water became exhausted. Complete details of the methods followed in this transfer will be found in a report by Mr. Rathbun in the Bulletin of the Fish Commission for 1888. The car reached Sacramento, June 22, and was dispatched to Monterey June 23, where 162 lobsters were deposited in the sea and the remaining 170 placed in floating boxes in the bay for deposit later. The loose eggs were put into hatching boxes June 24 and began hatching slowly June 28. The embryos were not liberated up to the time of closing this report. By this effort 332 lobsters and many eggs were carried across the continent in good condition and the requirements of successful transfer pretty thoroughly established. Still more favorable results are to be expected by making shipments in the spring or autumn, when the temperature will present less difficulty and the lobsters are in the most healthy state.

METHODS AND RESULTS.

REARING SHAD IN PONDS.

The experiments in rearing shad in confinement date back 4 years. In 1885 and 1886 the fry were placed in ponds containing young carp and a great many perch. The favorable results of these experiments, under most unpromising conditions, encouraged further investigation. As it was possible for shad to find their way into our ponds through the water supply, or by the drainage outlets from the river, I determined, in 1887, to renew the experiments under such conditions that the shad found in the ponds would certainly be accepted as the result of the stocking with fry. To this end I had a pond prepared at our Wytheville station, the same being fed by water drawn from Tate's Run, a small stream passing through the hatchery grounds. In June of that year I sent by messenger from Washington to Wytheville 40,000 shad fry, which were placed in the pond and left until the following October, when the pond was drawn, and we obtained, by count and estimate, 5,000 shad from 3½ to 4½ inches in length, or about 12½ per cent. of the number placed in the pond originally. The conditions were by no means favorable, for about 2,000 young carp 4 inches long were taken out with the shad, and the pond swarmed with cyprinoids which came in with the water supply. These fish are active and predaceous, and doubtless destroyed large numbers of the shad.

The experiment of the present season at Washington was carefully planned to exclude unfavorable conditions. The pond selected contained about 6 acres; it was thoroughly drained, and the bottom lay exposed to the frosts for some time; quicklime was used in the trenches to kill any eels or perch that might be in the mud; roots of hardy aquatic plants were planted in patches over the bottom, and then the pond was allowed to fill during the winter from the rains.

With the opening of the spring the vegetation grew up finely, and patches of green showed at numerous points. About 2,500,000 of fry were placed in the pond, and during the mild summer evenings, when the young shad were schooling at the surface and jumping after the flies, it looked as if a silver rain were falling on the water. Early in November, when the gates were opened to let the shad pass out into the river, it was a sight worth going to see; they were hours passing out in solid column, and a hand net dipped at random in the outlet conduit would bring up two or three hundred. We can of course only estimate numbers; every fry placed in the pond seemed to have a representative from 2½ to 3 inches in length. Dr. Hessel, the superintendent, estimates the proportion of survivals at over 60 per cent. I am certainly within limits in placing it at 30 per cent. The following account of the preparation of the pond and the feeding habits of the shad is from Dr. Hessel's report.

In May, 1888, shad fry were liberated in one of the carp ponds and suc-

cessfully reared on the supply of natural food. The pond in which young shad were reared was prepared by planting vegetation favorable to the growth of small crustacea such as *Daphnia*, *Cypris*, and *Cyclops*, upon which the young shad feed. The plants introduced were *Potamogeton*, *Natans*, *Gramineus*, *Crispus pectinatus*, and also bushy *Myriophyllum* of different varieties.

A *Nelumbium*, which was growing in the pond intended for shad, was found to be unfavorable to the experiment and it was removed. *Vallisneria* and *Polygonum amphibium* were added to the plants in the pond.

Shad fry were introduced April 26, 28, and 30; May 1, 2, 3, 4, and 6. On May 3 the fry were seen in water 3 to 4 inches deep, on sandy bottom, feeding upon minute crustacea. From May 3 to May 7, a raw north wind drove the animalculæ into deeper water, where the shad followed them and were lost from sight. Dr. Hessel began measuring the fish May 20, continuing at intervals of from five to fifteen days until October 10. The growth of the shad diminished towards the middle of August. The *Cyclops*, *Cypris*, etc., although very abundant in the pond, were too small to satisfy their appetite and the larger *Gammarus pulex* was not present. In order to determine whether or not the young shad would eat the fry of other fish, Dr. Hessel made the following experiment:

At those points of the pond mostly frequented by shad I placed, about June 20, from 80 to 100 carp, ten days old. The young shad were then about 3 centimetres long, and the carp about 6 millimetres (or one-fourth of an inch).

The shad at once attacked the carp, and ate them up. I can not say that it is the nature of the shad to eat other fish; but in this case it may have been the want of crustacea of proper size which compelled them to eat the carp fry, and it does not necessarily follow that they do so in open waters of rivers and the ocean. I am satisfied, however, that they do this in inclosed waters, from the following fact:

In 1886 a few cans of shad fry from the U. S. Fish Commission were deposited in the same point, in order to test the practicability of raising shad in the pond. The shad grew rapidly. In May the carp in the pond spawned and after the eggs were hatched an abundant supply of young carp was observed. The carp fry gradually disappeared and when the pond was drawn off, instead of 120,000 young carp which were expected, only 25,000 were taken out. At the same time, we found about 12,000 young shad 6 or 7 inches in length, which was three or four times the average size of the shad raised this year.

They accomplished this abnormal growth at the expense of the young carp which they had devoured.

October 27, 1887, about 800,000 young, of 2½ to 3 inches, were liberated and entered the Potomac.

This method is capable of general application as a means of stocking our rivers. I would select low meadows along the tidal portions of streams, which are bare at low water; by dikes I would exclude the tide water and allow the ponds to fill by seepage or surface drainage.

Ponds of several hundred acres area may be constructed at moderate expense. Each season I would stock these ponds with fry, and in the fall open the sluice gates and let the shad pass out into the rivers. Pur-

suing this method, with our capacity for producing fry, we could turn out each season into the Atlantic rivers 100,000,000 shad from 3 to 4 inches in length. The system of rearing ponds with a supply of natural food will, I am sure, be adopted in the end both for the production of shad and the various *Salmonidæ*.

SOME RESULTS OF ARTIFICIAL PROPAGATION.

PROPAGATION OF SHAD.

Since 1875 the U. S. Fish Commission has been engaged in the artificial propagation of the shad.

Prior to 1880 the immediate object and motive of the work was the production of fry, with a view to their introduction and acclimation in those river basins of the United States in which the species is not indigenous.

The fisheries census of 1880 and special investigations made under the immediate direction of the U. S. Commissioner of Fish and Fisheries revealed plainly the fact that there was a rapid decline in the productiveness and value of the shad fisheries in the Atlantic coast rivers, and that this decline was the inevitable result of adverse conditions, which were apparently beyond direct regulation or control by the General Government.

The Fish Commission could offer but one hope, namely, the artificial propagation and distribution of the young. Would these means be adequate; could we, by rescuing from waste the eggs taken from the shad captured in the nets of the fishermen, and destined for the market—by impregnating, hatching, and returning them to their native waters—arrest this decline, and, in the face of adverse conditions, determine a steady and progressive improvement in one of our most important fishery industries?

This was the definite problem to the solution of which the Commission addressed itself. Systematic development and extension of the shad-hatching operations of the Commission were undertaken with the definite purpose of testing the value of artificial propagation as a chief reliance in maintaining an important fishery, in the face of most unfavorable conditions, and—in a field which nature had abandoned as hopeless—determining a steady increase in value and production.

In 1880 the aggregate catch of shad in Atlantic coast waters, from Connecticut to North Carolina, was 4,140,968. The fisheries were steadily declining and there was a general and well-founded apprehension of their ultimate extinction. The work of stocking the streams was steadily prosecuted, increasing numbers of fry being planted each year, the total plant in 1888 aggregating 153,890,300 fry.

In 1885 a careful census of the shad fisheries of the region indicated was taken. The result of this was encouraging, since it showed an

aggregate increase in the shad fisheries of 1885 over 1880 of 1,032,963 shad, representing 4,131,852 pounds of increased food supply and an increased money value of $206,592. Like returns were obtained for 1886, 1887, and 1888.

These are summarized in the following table:

Aggregate catch of shad in Atlantic rivers from Connecticut to North Carolina for 1880, 1885, 1886, 1887, *and* 1888.

Year.	Number taken in salt and brackish waters.	Number taken in the rivers.	Total catch.	Increase over 1880.
				Per cent.
1880...	2, 549, 544	1, 591, 424	4, 140, 968	....
1885...	3, 267, 497	1, 906, 434	5, 172, 931	25
1886...	3, 098, 768	2, 485, 000	5, 584, 368	34
1887...	3, 813, 744	2, 901, 661	6, 715, 405	62
1888...	5, 010, 101	2, 650, 373	7, 660, 474	85

By reference to this it will be seen that there has been a steady increase in the productiveness and value of our shad fisheries.

In 1885 the percentage of increase over 1880 was 25 per cent.; in 1886 the percentage of increase over 1880 was 34 per cent.; in 1887 the percentage of increase over 1880 was 62 per cent.; in 1888 the percentage of increase over 1880 was 85 per cent., the money value of the increase of 1888 over 1880 aggregating $704,101.

The significance of this result as measuring the value of the work of the Commission in the improvement of our fisheries will be better appreciated when it is understood how unfavorable to natural reproduction are the existing conditions under which the shad fisheries are prosecuted. Dams and other obstructions in the rivers exclude the shad from their natural spawning ground and vastly curtail the area of the feeding grounds for the young fish during their river life.

With this contraction of the area of spawning grounds the possibilities of natural reproduction in the rivers are diminished *pro tanto*, for in all our streams the larger area of favorable spawning and feeding grounds lies above the insurmountable obstructions.

In the lower reaches of our rivers, which are still accessible to the shad, the restricted spawning grounds are industriously and assiduously swept with drift net and seine, and innumerable fyke nets and pounds effectually bar all approaches, so that natural reproduction is in great measure impracticable even for the shad that find their way into the rivers and to the vicinity of their spawning grounds.

More serious than all, however, has been the transfer of the shad fisheries to the estuaries of the rivers and the substitution of the pound net for gill net and seine. In consequence of this change in the location of the fishing grounds the larger proportion of the shad captured

are now taken in salt or brackish waters, in which natural reproduction can not be accomplished.

Indeed, so small is the proportion of the seasonal runs of shad, which succeed in making their way into and up our rivers and reaching their spawning grounds, that natural reproduction has ceased to be a material factor in influencing the conditions affecting our shad fisheries.

The increased production of this fishery is to be attributed to the fish-cultural work of the United States and State Fish Commissions. The increased value of this fishery is a measure of the economic value of this work to the people of the country.

INTRODUCTION AND ACCLIMATION OF NEW SPECIES.

Experiments in acclimation have always constituted an important feature of the work of the Commission.

These have been directed as well to extending the area of distribution of our most valuable indigenous species as to the introduction from other countries of species promising important additions to our economic resources.

The Shad (*Clupea sapidissima*).

The introduction of the shad into the waters of the Pacific coast, and its multiplication there so as to become an important acquisition to the food resources of that region, is a remarkable illustration of the valuable results to be expected from well directed efforts in acclimation.

Several plants were made in the Sacramento River at Tehama, as follows:

In 1871	12,000
In 1873	35,000
In 1876	99,000
In 1878	150,000
In 1880	250,000

From these slender colonies, aggregating less than 1 per cent. of the number now annually planted on our Atlantic slope rivers, the shad have multiplied and distributed themselves along 2,000 miles of coast from the Golden Gate of California to Vancouver Island in British Columbia. They are abundant in some of the rivers, common in most of them, and occasional ones may be found everywhere in the estuaries and bays of this long coast line.

Prior to our experiments on the west coast it was a dictum of fish culture that fish planted in a river would return to it when mature for the purpose of spawning. The result of these experiments has been to demonstrate that this *instinct of nativity*, should it really exist, is in this case dominated by other influences, which have dispersed the shad planted in the Sacramento widely beyond the limits which we had assigned to them, and in the most unexpected direction.

The cause is probably to be sought in the genial influences of the

Japan current, which brings the warmth of equatorial Asia to temper the extremes of Arctic climate on the southern shores of the Alaskan Peninsula, and thence sweeping to the south, carries tropical heats to the latitude of San Francisco. Repelled on the one hand by the low temperature of the great rivers and fringe of coast waters, and solicited on the other by the equable and higher temperature of the Japan current, the shad have become true nomads, and have broken the bounds of the hydrographic area to which we had supposed they would be restricted. Following the track of the Asiatic current, and finding more congenial temperature as they progress, it is not unreasonable to expect that some colonies will eventually reach the coast of Asia, and establish themselves in its great rivers.

DIVISION OF SCIENTIFIC INQUIRY.

Preparations for the cruise to the Pacific coast detained the steamer *Albatross* in port from the first of January until the middle of September, 1887. During this period new boilers were constructed and put in place, necessitating several changes in the arrangement of the rooms adjoining the scientific quarters. The ship was also thoroughly overhauled and the equipment brought up to its full complement. It had been intended that the steamer should spend the summer of 1887 in making further explorations on the Atlantic fishing grounds, but the delays in completing her repairs rendered this impossible. In April, however, she proceeded to Fortress Monroe and supplied the United States steamer *Thetis*, then about to leave for the North Pacific and Arctic Oceans, with a dredging outfit, comprising several beam trawls, dredges and towing nets, dredge rope, and the necessary appliances and alcohol for preserving specimens. This material was furnished at the request of her commander, Lieut. William Emory, U. S. Navy, who has planned to carry on extensive investigations respecting the fisheries and marine zoölogy of the coasts that he will visit. Lieutenant Emory and several of his officers were given a short dredging trip on board the *Albatross* in order to instruct them in the methods of using the apparatus. September 14 the *Albatross* left Baltimore and put to sea, bound for Wood's Holl, Massachusetts. About 3 days were spent on the way in dredging and making observations along the inner edge of the Gulf Stream in depths of 102 to 1,276 fathoms. This cruise was taken as a trial trip for the purpose of testing the new boilers, which gave entire satisfaction. A month was occupied at Wood's Holl in putting the ship to rights and in making final arrangements, after which she returned to Washington to await orders for the voyage to the west coast. Coal and other supplies were subsequently obtained at Norfolk, from which port the *Albatross* sailed for San Francisco November 21. Lieut. Commander Z. L. Tanner, U. S. Navy, was in command of the steamer, while the civilian scientific staff was in charge of Prof. Leslie A. Lee, of Bowdoin College, assisted by Mr. Thomas Lee, Mr. Charles H. Townsend, and Mr. Dennis Cole.

The reasons for dispatching the *Albatross* to the Pacific coast of the United States have been stated in previous reports. It was considered that the benefits received by the Atlantic fisheries from the investigations of the Fish Commission were sufficiently important to warrant the extension of the work to the western coast, where the off-shore fishing grounds had never been studied or developed, although known to be extensive and valuable. Demands for information respecting their location, characteristics, and productiveness had frequently been made upon the Commissioner, and the late Professor Baird had carefully matured his plans with a view to instituting the desired inquiries, but his sudden death left their fulfillment to his successor. The transfer of the *Albatross* to the Pacific coast was sanctioned by the act of Congress, approved August 4, 1886, which provided for the necessary alterations in her machinery and for the additional expenses of the voyage to San Francisco. In accordance with the arrangements made by Professor Baird, instructions were given to carry on a limited amount of exploring work during the cruise around South America, as it was thought that valuable information might be obtained respecting the distribution of some of the oceanic fishes which frequent the coasts of the United States. It was also considered important to take advantage of the opportunity to study the methods of fishing practiced on the South American coast. Occasional dredgings, chiefly in moderate depths of water, were made during the progress of the cruise, together with the customary physical observations and surface towings. At coaling ports the scientific assistants were principally occupied in collecting and studying the local fishes, and in obtaining data bearing upon the fishery methods and statistics. The fish markets were visited and complete series of the species offered for sale were secured and forwarded to Washington. The places where opportunities occurred for this kind of work were as follows: The Island of St. Lucia in the West Indies, Bahia, Montevideo, Sandy Point, Lota, Panama, Acapulco, and La Paz, the last two being located on the west coast of Mexico. Dredging work and hydrographic observations were carried on through the entire length of the Straits of Magellan, a comparatively unknown region zoölogically, and a short stop was made at the Galapagos Islands, off the coast of Ecuador. At the latter place a number of specimens of the edible land tortoise peculiar to those islands were secured and carried alive to San Francisco. It was intended to plant them on one of the islands off the coast of Florida, in the hope that they might become acclimated on our own coast, but, unfortunately, they barely survived the journey across the continent. Collections of shore fishes were obtained by seining at several localities on the outer coast of Lower California, and a few dredge hauls were made off California, one of the latter containing a new species of edible flounder, which appears to occur in considerable abundance.

The scientific and practical results of this cruise can not fail to be of great importance. The greater part of the collections obtained has

been apportioned among prominent specialists in the several groups for study and their reports are awaited with interest. The general scientific results will be discussed by Prof. Leslie A. Lee; the narrative of the cruise by Lieutenant-Commander Tanner will be found in the appendix to this volume. The *Albatross* arrived at San Francisco the middle of May, 1888, the time previously determined upon, and preparations were immediately begun for the first cruise to the Alaskan fishing grounds, on which she started July 4.

The great extent of the western seacoast of the United States with its varied climate will make it possible to utilize nearly the entire year in carrying on the investigations of the steamer *Albatross*. The exploration of the Alaskan cod and halibut grounds, which reach well up into Bering Sea, must necessarily be limited to the summer months, while the winter is best adapted to the work along the coast of Southern California. The hydrography of this entire region is comparatively little known outside of the harbors and shore waters, and it will, therefore, be of great importance to conduct extensive series of soundings, in order to determine the position and extent of the fishing banks, a work not generally necessary on the Atlantic coast. The study of their resources and their physical and biological characteristics can, however, be made conjointly with the same, and it is expected that results of much value to the fishermen will be obtained before the close of the next fiscal year.

During the year and a half ending June 30, 1888, the steamer *Fish Hawk* was employed but little in this branch of inquiry. From August 9 to September 6, 1887, however, she was stationed at Wood's Holl, Massachusetts, and rendered some assistance in the investigations in that region, making several dredging trips to Vineyard Sound, Buzzard's Bay, and the shallow waters off Martha's Vineyard and Nantucket.

Within the period covered by this report the schooner *Grampus* has made several important explorations and has demonstrated her utility for this class of work. From the latter part of April until the last of May, 1887, while in command of Capt. D. E. Collins and with Dr. T. H. Bean as naturalist, she was engaged in cruising on the early mackerel grounds between Cape Hatteras, North Carolina, and Cape Cod, Massachusetts, for the purpose of studying the schools of mackerel as they approach the coast, and their subsequent movements with relation to temperature, the abundance of food, etc. The schooner was well equipped with the necessary scientific and fishing appliances, and succeeded in obtaining many valuable observations which have been published in the Fish Commission Bulletin for this year. A part of the time she kept company with the fishing fleet, and at others was cruising independently with the view of ascertaining whether the mackerel could be found in advance of the fishing centers or in other directions. During the first part of the season the mackerel were scarce and small. Sea birds,

cetaceans, and the various other marine forms, which generally accompany the schools and indicate their position and size, were less abundant than usual. Bad weather also prevailed most of the time and this undoubtedly interfered with the schooling of the fish at the surface. Most of the schools sighted, even during the latter part of the cruise, were too deep in the water to be reached by seining, and it is probable that a large proportion of the fish passed northward unobserved. They also appeared to move nearer the land than has generally been recorded.

During the following summer, beginning the first part of July, the *Grampus* extended its researches respecting the distribution and abundance of mackerel along the coasts of the British Province as far north as Labrador. She was then in charge of Capt. J. W. Collins. The principal object of the trip was to verify the recent reports concerning the appearance of mackerel off the northeast coast of Newfoundland. Following the coast of Nova Scotia as far as Canso, the *Grampus* entered the Gulf of St. Lawrence, and sailed as far north as the Magdalen Islands. Thence she proceeded to St. John's, Newfoundland, and along the outer side of Newfoundland to the Straits of Belle Isle. No mackerel were observed at any point; but many natural history specimens and physical observations were obtained. Mr. F. A. Lucas and Mr. William Palmer, of the U. S. National Museum, accompanied the schooner as naturalists, and in addition to the regular work of the cruise they were allowed to land and make shore collections at the different harbors visited.

The work begun in the spring of 1887 was continued by the *Grampus* during April, May, and June, 1888, Capt. D. E. Collins being again in command, and Dr. T. H. Bean acting as naturalist. The cruising ground was the same as in the previous year. Only small schools of mackerel were encountered, and those not until late in May. Low water temperatures prevailed during the early part of the season, and the mackerel food was found to be abundant only in streaks or scattered patches. Over 250,000 floating fish eggs taken in the surface nets were carried to Wood's Holl and hatched, the embryos being preserved for identification. Should these eggs prove to belong to useful species, it will probably be expedient to make a practice of collecting and hatching them on a large scale. A few days in May were occupied in investigating the reproduction of the menhaden in lower Chesapeake Bay. The experiment of carrying living mackerel in the schooner's well proved successful, and it will therefore be possible to undertake the reproduction of this species at one of the coast stations of the Commission.

Dr. T. H. Bean spent the summer of 1887 in collecting and in studying the habits of fishes in the vicinity of Great Egg Harbor Bay, New Jersey, chiefly for the purpose of determining the changes that have taken place in the fish fauna of the New Jersey coast during the past

thirty-three years, Professor Baird having made a careful investigation of the same region in 1854. The latter obtained sixty-seven species, of which eleven were not found by Dr. Bean, who succeeded, however, in securing ninety species, thirty-five of which were additions to the list published by Professor Baird. The total number of species now recorded from this region is one hundred and one.

The Wood's Holl laboratory was occupied as usual during the summer of 1887 in the interest of scientific inquiry. Professor Baird was present up to the time of his death, August 19, but as he was seldom able to give personal attention to the conduct of the work, his duties were assumed by the Acting Commissioner, Mr. T. B. Ferguson. The biological laboratory was in charge of Prof. A. E. Verrill, of Yale College, assisted by Mr. Richard Rathbun. Those in attendance during the summer were as follows: Prof. S. I. Smith, of Yale College; Prof. Leslie A. Lee, of Bowdoin College; Mr. Sanderson Smith, of New York; Prof. Edwin Linton, of Washington and Jefferson College, assisted in his work by Mrs. Linton as artist; Prof. B. F. Koons, of the Storrs Agricultural School; Mr. J. H. Blake, of Cambridge, as artist; Mr. Thomas Lee, and Mr. Peter Parker, of Washington; Miss K. J. Bush, and Miss C. E. Bush, assistants of Professor Verrill; and Mr. A. H. Baldwin and Miss M. J. Rathbun, assistants in the U. S. National Museum. Dr. J. H. Kidder was in charge of the physical and chemical laboratory, and Mr. William P. Seal of the aquaria. Tables in the laboratory were assigned to Mr. S. Watase, of Johns Hopkins University, and Mr. Miyabe, of Harvard University. Dr. Osler, of Philadelphia, was also present for a short time. Mr. V. N. Edwards, who is permanently employed at the station, acted as general field assistant. The attention of the party was divided between the care and study of the collections brought in by the steamers *Fish Hawk* and *Albatross* and the investigation of the local fauna and fisheries. As above explained, the *Albatross* made only one trip in connection with the Wood's Holl Station, but the short cruises of the *Fish Hawk* in the neighboring waters furnished considerable material. Seines were constantly in use along the shores of Vineyard Sound and Buzzard's Bay, and many fishes were secured in the fish traps of the vicinity.

The taking of temperature observations at the principal light-houses, light-ships, and signal stations along both seacoasts of the United States and on many of the interior lakes and rivers, as described in previous reports, was continued during the entire year, through the courtesy of the Light-House Board and the Chief Signal Officer. The preparation of reports covering the investigations of the steamers and field parties of the Commission has been intrusted to the same personnel as last year. Among the collaborators in this department may be mentioned Prof. A. E. Verrill, and Prof. S. I. Smith, of Yale College; President David S. Jordan, of the University of Indiana; Dr. T. H. Bean, Dr. J. H. Kidder, and Mr. Richard Rathbun, of Washington;

Prof. Leslie A. Lee, of Bowdoin College; Prof. Edwin Linton, of Washington and Jefferson College; and Mr. Sanderson Smith, of New York.

DIVISION OF FISHERIES.

In reorganizing the work of the Commission I felt that the importance of the fisheries demanded the creation of a division which should consider their commercial side in all its bearings. In 1885 the collection of fishery statistics was begun by Professor Baird, with Mr. R. E. Earll in charge of the work. In 1887 Prof. G. Brown Goode, who was appointed Commissioner after the death of Professor Baird, established a division of statistics, with Mr. Earll at its head. This arrangement continued until in May, 1888, when Mr. Earll tendered his resignation from the Commission. I then decided to carry into effect my system of reorganization, by creating a Division of Fisheries, and on May 24, 1888, appointed Capt. J. W. Collins in charge, with instructions to organize and carry on its work. The full accomplishment of this plan was delayed, however, by the necessity of detaching Captain Collins for the preparation and management of the Commission's exhibit at the Centennial Exposition of the Ohio Valley and Central States, held at Cincinnati, Ohio. A temporary organization of the division was effected and the work of securing information concerning the fisheries begun.

In the beginning of 1887 the office force engaged in collecting statistics of the fisheries included R. Edward Earll, assistant in charge; Dr. H. M. Smith, M. M. Snell, and W. H. Abbott, clerks.

Mr. H. R. Center was added to this personnel in November, 1887. During the interval between the resignation of Mr. Earll and the appointment of Captain Collins Dr. H. M. Smith assumed charge of the office.

Mr. W. A. Wilcox acted as a local agent of the Commission until December, 1887, when he was directed to obtain special information in Maine and Massachusetts, for the use of the International Fisheries Commission. After completing this work he was assigned to office duty in Washington until again detailed, in the latter part of June, 1888, for field work in Massachusetts. About the same time Mr. Luther Maddocks was ordered to Maine for similar duty.

The routine work has included the preparation of reports and reference files on the fisheries, based on materials received from the following sources:

Daily reports from the Boston Fish Bureau.

Daily reports from the American Fish Bureau, Gloucester, Massachusetts.

Weekly reports from Capt. S. J. Martin, on the Gloucester fisheries.

Reports from field agents of the Commission.

Newspaper articles on the fisheries, fish culture, fish protection, etc.

Correspondence with New England vessel owners and masters.

Reports from and correspondence with collectors of customs.

Correspondence with Treasury Department officials.

The circular issued by the Treasury Department to the collectors of customs is one of the most valuable means of obtaining information concerning the statistics of fisheries. 3,445 of these reports were forwarded to the Commissioner in the calendar year of 1886, 2,535 in the first half of 1887, and 5,436 during the fiscal year ended June 30, 1888. They are increasing in value every year and have been of great assistance in preparing the compilations elsewhere mentioned.

From the materials above mentioned tables can be prepared at short notice, showing in detail almost every aspect of the vessel fisheries for the food fish of any State or section. The reports, however, do not include the shore fisheries and those devoted to the whale, seal, and walrus.

The division has conducted an extensive correspondence in order to obtain these data. To the Executive Departments, the committees of Congress, and the International Fisheries Commission much information has been furnished on matters concerning the fishery relations between the United States and Canada.

From January 1, 1887, to June 30, 1888, 888 letters were written and sent from the office, besides 2,000 cyclostyle forms to collectors of customs and vessel owners, filled out to suit individual cases, numerous replies to private parties seeking information, and letters to field agents relative to their work.

In response to requests received from the Department of State, the International Fisheries Commission, the Congressional committees on Fisheries and Foreign Affairs, and from other Departments of the Government, and private individuals, twenty-four tables and statistical statements were prepared. These include lists of American vessels whose fishing operations were inconvenienced by the Canadian government; American vessels entering British North American ports and fishing grounds; [illegible] products imported from and bait exported to Canada; American vessels fishing on offshore grounds, including references to the fishing centers, baiting localities, and average catch; statistics of special fisheries, as the halibut, cod, mackerel, and menhaden; accounts of the fisheries of special ports, as Philadelphia and Camden; and statements of the number and nationality of New England fishermen and the value of the fisheries.

At the request of the International Fisheries Commission Captain Collins furnished "some reasons why the fishermen of Nova Scotia prefer to use salt clams (*Mya arenaria*) for bait in the Bank hand-line cod fisheries." For the use of the same Commission, and at the instance of the Department of State, he prepared four large colored maps covering the region between Cape Hatteras and Labrador, at the intersection of the fifty-third parallel of north latitude, and showing graphically the geographical distribution of the marine fishes most important for food and bait, the areas of greatest abundance, the principal fishing ports and baiting stations, and various other facts bearing on the fishery relations between the United States and Canada.

ASSIGNMENT OF DUTIES.

The work of the Division of Scientific Inquiry has been directed by Mr. Richard Rathbun, who has been intimately associated with this branch of the service since 1874. Systematic investigations of various problems having either direct or ultimate economic importance have been projected or are now in progress under his supervision, and promise results alike valuable to science and its economic applications.

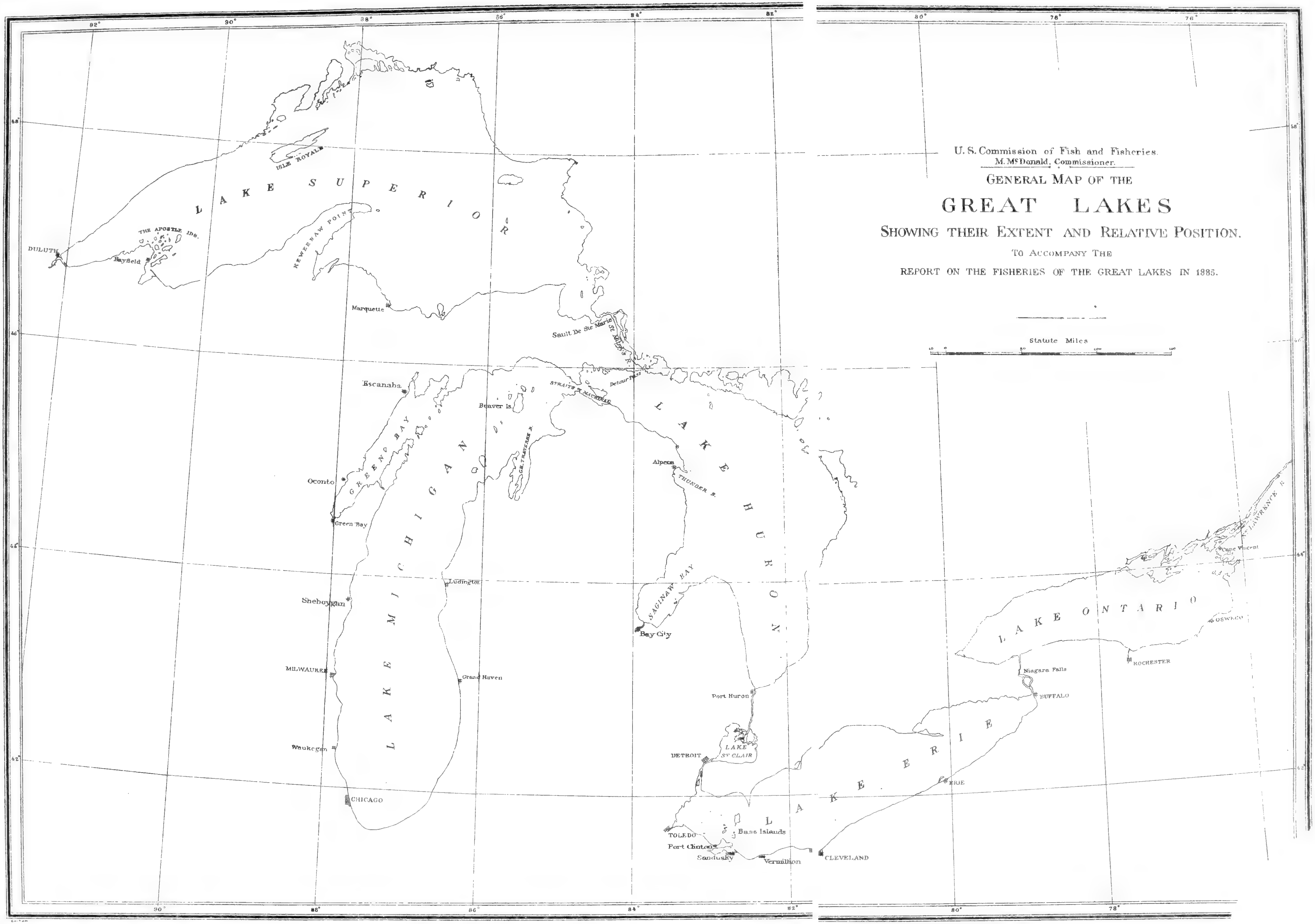
The work of the Division of Fisheries has been directed by Capt. J. W. Collins.

The Commissioner retains charge, for the present, of the Division of Fish Culture.

MARSHALL McDONALD,
Commissioner.

INDEX TO REPORT OF COMMISSIONER.

APPENDIX.


U. S. Commission of Fish and Fisheries.
M. McDonald, Commissioner.
General Map of the
GREAT LAKES
Showing their Extent and Relative Position.
To Accompany The
Report on the Fisheries of the Great Lakes in 1885.
Statute Miles
LAKE SUPERIOR
ISLE ROYALE
THE APOSTLE IDS.
KEWEENAW POINT
DULUTH
Bayfield
Marquette
Sault De Ste Marie
Escanaba
Beaver Is.
Detour Pass
GREEN BAY
LAKE MICHIGAN
Oconto
Green Bay
LAKE HURON
Alpena
THUNDER B.
SAGINAW BAY
Bay City
Sheboygan
Ludington
MILWAUKEE
Grand Haven
Port Huron
Waukegan
CHICAGO
DETROIT
LAKE ST. CLAIR
LAKE ERIE
TOLEDO
Bass Islands
Port Clinton
Sandusky
Vermillion
CLEVELAND
ERIE
BUFFALO
Niagara Falls
LAKE ONTARIO
ROCHESTER
OSWEGO
Cape Vincent

1.—REVIEW OF THE FISHERIES OF THE GREAT LAKES IN 1885, COMPILED BY HUGH M. SMITH AND MERWIN-MARIE SNELL, WITH INTRODUCTION AND DESCRIPTION OF FISHING VESSELS AND BOATS BY J. W. COLLINS.

ANALYSIS.

I.—INTRODUCTION.

1. THE OBJECTS OF THE INVESTIGATION AND REPORT.

The inquiry the results of which are embodied in this review was instituted by Prof. Spencer F. Baird, then U. S. Commissioner of Fish and Fisheries. His object was the obtainment of as full and definite information concerning the fisheries of the Great Lakes as it was practicable to secure. The expiration of the fishery clauses of the Treaty of Washington in 1885 made it important that the actual condition of the fisheries on our northern border should be well understood, in order that the Government might be in possession of such facts as would be needed in shaping legislation or conducting negotiations relative to the international questions connected with the fisheries prosecuted adjacent to Canadian territory.

The lake fisheries have attained a development in recent years which has materially increased their importance. There is also an intimate connection between the fisheries prosecuted by the Americans and Canadians on the lakes, and legislation or negotiation bearing on the matter of fishery relations between the United States and Canada might be influenced considerably by the conditions existing in the lake region.

The rapid increase in the population of the west was known to have exercised a marked influence on the development of the fishery interests on the lakes, and it was believed that the changes which had taken place since the census year of 1880 were so important as to make the figures and facts obtained at that time no longer a safe basis for important action.

It is also a fact that no such exhaustive investigation into the condition of the lake fisheries and their geographical and industrial relations had previously been prosecuted, and there was a lack of detailed information that was necessary to place the Government in full possession of all the questions involved.

The artificial propagation of fish in the region under consideration, by the National and State commissions, is a matter of much consequence and one which has engaged the active interest of the U. S. Fish Commission. This inquiry had, therefore, an additionally important object, since it is only by such investigations that the full effects

of fish culture can be comprehended or intelligently understood. It is apparent that statistics, and such other information as is contained in this review, are necessary for the purpose of comparison, and furnish the only means for obtaining a definite understanding of the changes which may occur in fishing as a result of artificial propagation.

In the preparation of the review an effort has been made to present in considerable detail all the salient points, among which may be specially mentioned the geographical aspects of the fisheries, their commercial and economic importance, and the history of particular events which have been influential in their development. Less consideration has been given to natural history and the various scientific problems connected with the fisheries.

There is a marked similarity in the fisheries of different sections of each lake, which have been treated separately in this review. On this account, and because of the desire to make each geographical section complete in itself, in order that there might be no misconception in regard to the relations it bore to the entire fishing industry on the lakes, a certain amount of repetition was unavoidable.

The fisheries of some localities have been discussed in great detail for special reasons, while less consideration has been given to similar fisheries prosecuted in adjacent waters. The same is true in regard to the discussion of the methods of preparation of fish and secondary products.

Particular attention and considerable space has been given to fisheries that are unique or which have recently been introduced or developed, and whenever it seemed practicable to advise changes to benefit the fishery, suggestions have been made for improvement in fishing apparatus, methods, and other conditions bearing upon the industry under consideration.

2. HISTORY OF THE INVESTIGATION.

The investigation of the lakes was prosecuted under the immediate direction of Mr. R. Edward Earll during the months of August, September, October, and November, 1885. He was assisted in the field by Messrs. Merwin-Marie Snell, Frank N. Clark, Seymour Bower, S. P. Wires, J. Frank Ellis, and E. A. Tulian, all members of the U. S. Fish Commission.

As a preliminary step, the Lake Region was divided into sections, to which the different agents were assigned. It was thus possible to cover the entire coast-line, over 3,500 miles in length, in a comparatively short time, and for the agents of the Fish Commission to visit each fishing center and have personal interviews with the fishermen and others interested in the fisheries.

The particular sections of coast canvassed by the different agents were as follows:

R. Edward Earll and Merwin-Marie Snell, Lake Superior entire;

Lake Michigan on the west side south to Chicago, Illinois, and on the east side south to Frankfort, Michigan.

Frank N. Clark, Lake Huron, from Hammond's Bay north to the Straits of Mackinac and eastward to the Canadian line.

S. P. Wires, Lake Huron, from Hammond's Bay to Ottawa Bay.

E. A. Tulian, Lake Huron, from Ottawa Bay south to Port Huron, Michigan; St. Clair River, Lake St. Clair, Detroit River.

Seymour Bower, Lake Erie, from the mouth of the Detroit River to and including Erie, Pennsylvania.

J. Frank Ellis, Lake Michigan, from Chicago up the eastern shore to Frankfort; Lake Erie, east of Erie, Pennsylvania; Lake Ontario entire.

3. PREPARATION OF THE REPORT.

The compilation of this review has been delayed for various reasons, and at the time I was appointed in charge of the Division of Fisheries, in May, 1888, it was hardly more than begun. Chief among the reasons referred to were the press of other matters connected with the routine work of the office, the absence in the field, for a greater or less time, of each of those intrusted with the preparation of the report, and the small force available for writing the details of fisheries of such magnitude from field-notes, many of which had been collected by others.

Appreciating the importance of the publication of material gathered in the investigation previously alluded to, I made arrangements at the earliest opportunity for the completion of this review, and during my absence from Washington, in the summer and winter of 1888, the work was placed under the immediate supervision of Dr. Hugh M. Smith.

The review is based chiefly on data obtained in 1885. In some instances, however, it has been practicable to bring the information down to a later date, the object being to give a clearer conception of the special fisheries under consideration. It has been compiled by Hugh M. Smith and Merwin-Marie Snell. I have added descriptions and illustrations of the boats and vessels engaged in the lake fisheries in order that their peculiarities might be fully understood.

It has been deemed advisable to publish with the review figures of the different species of fish that constitute objects of the lake fisheries.

Outline maps show in detail the relations of the lakes to each other, and the condition of the pound-net fisheries at the time the investigation was made, so far as relates to the number and location of pounds in each lake. In a few instances, however, an apparent slight discrepancy occurs between the number of pound-nets on the maps and the number mentioned in the text. This is accounted for by the fact that the text includes the greatest number of nets in use at any time during the year, while the charts show the actual number and location of the pounds at the time the various sections were visited by the

agents of the Commission. It was not practicable to ascertain the location of apparatus which was put down after the region had been visited, although the number of nets set after the canvass had been made by the agents of the Commission was accurately obtained from the fishermen, who sent the information to Washington on circulars left with them for that purpose. The variation is comparatively unimportant, but, nevertheless, might give rise to some misunderstanding and question if not explained.

4. IMPORTANCE OF THE LAKE FISHERIES.

In order that the increasing importance of the lake fisheries may be fully appreciated, it is only necessary to call attention to the extent of country over which the products are distributed; to the large and growing population dependent upon those fisheries to a greater or less extent for their food supply; to the thousands of men who find profitable employment in fishing or as preparators of fishery products; to the capital invested in the industry; and to the other important occupations related to or dependent upon the fisheries, the most noticeable of which is salt mining, ice harvesting, barrel and box making, boat and vessel building, and net and twine manufacture.

But while commercial fishing is the chief and practically the only subject considered in this review, the importance of the pleasure fishing upon the lakes has been incidentally referred to, and this is a matter that it seems appropriate to call attention to here. Although there are no statistics to show the amount of fish caught by sportsmen and other pleasure seekers, and it is not probable that any such data could be easily and satisfactorily obtained, it is, nevertheless, known that the quantity and value of the fish so taken amount to a large aggregate. As an illustration of the importance this pleasure fishing assumes in some localities, the writer feels safe in estimating, from his own observation, that no less than $10,000 worth of fish are taken for each year from the breakwater at Chicago by men, women, and children who go out there in summer for a day's outing, and nearly all of whom catch more or less fish.

5. ARTIFICIAL PROPAGATION OF FISH.

Of all the questions involved in a consideration of the lake fisheries and their continued success none is of greater importance than that of the effect which may be produced upon the abundance of fish by artificial breeding. Allusion has been made to this in a previous paragraph, where was shown the special need of obtaining statistics from which proper deductions could be made regarding the effect of fish culture. Indeed, the matter was thought to be of such great importance that a preliminary inquiry had been made previous to 1885 to ascertain the effect of fish hatching. The U. S. Commissioner of Fisheries, in his

annual report for 1884, called attention to a visit made by Mr. Frank N. Clark to the principal fishing stations on Lake Erie, with a view to ascertain whether the planting of 82,000,000 whitefish fry between 1875 and 1882 had been productive of good results. One-half of this number, being planted in 1881 and 1882, would not have been of sufficient size to be caught, and could not therefore affect the fisheries as early as 1884. Although Mr. Clark found that the constant increase in the number of nets tended to make up for any apparent decrease in the abundance of fish, as the result of his inquiry he was of the decided opinion that not only had the decrease been arrested, but that there had been a tangible and satisfactory increase, taking all things into consideration.

For about thirteen years prior to the investigation made by Mr. Earll and his associates, more or less had been done in hatching fish artificially on the lakes by the U. S. Fish Commission, the fish commissions of the states bordering on the lakes, and by private individuals.

Much of the early work was, however, experimental, the efforts of those interested being of necessity directed principally toward developing methods, and thus laying the foundations for effective systematic work. The question of acclimatization, which is so closely allied to fish-breeding, was also a matter that attracted attention.

The first attempts at artificial propagation in the lake region were made by the State Fish Commissions, and resulted in planting a small number of whitefish fry annually for some years prior to 1880–'81, about which time the work of the National Commission began. But before the winter of 1882–'83 the work was conducted upon too small a scale for its effects to be apparent, and, indeed, it did not attain anything like adequate proportions until two or three years later.

The amount of whitefish hatched and put into the several lakes by the U. S. Fish Commission, to and including 1885, is shown in the following table compiled from the Annual Reports. The figures for 1875–'76 represent fish hatched at the expense of the Commission by Messrs. N. W. Clark & Son, in their hatchery at Northville, Michigan, which was not purchased by the Government until August, 1880.

A.—*Table showing the number of whitefish artificially propagated and put into the waters of the Great Lakes by the U. S. Fish Commission prior to* 1885.

Year.	Lake Superior.	Lake Michigan.	Lake Huron.	Detroit River.	Lake Erie.	Lake Ontario.	Total.
1875–'76	....	130, 000	....	....	1, 000, 000	....	1, 130, 000
1880–'81	....	5, 000, 000	2, 000, 000	1, 000, 000	1, 250, 000	....	9, 250, 000
1881–'82	....	7, 500, 000	2, 000, 000	1, 250, 000	3, 500, 000	3, 500, 000	17, 750, 000
1882–'83	4, 000, 000	11, 000, 000	16, 015, 000	....	7, 000, 000	9, 000, 000	47, 015, 000
1883–'84	6, 000, 000	20, 000, 000	27, 500, 000	....	12, 000, 000	6, 000, 000	71, 500, 000
1884–'85	4, 000, 000	25, 060, 000	34, 000, 000	8, 000, 000	17, 000, 000	....	88, 060, 000
Total	14, 000, 000	68, 690, 000	81, 515, 000	10, 250, 000	41, 750, 000	18, 500, 000	234, 705, 000

Considering the slow growth of the whitefish—three to four years being required for it to attain maturity—it will be seen that the effect of artificial fish-breeding on the lakes could not be fully ascertained, nor could it be fully appreciated in 1885, for sufficent time had not then elapsed to put fish culture to a crucial test. Still, from the facts obtained at that time, the fair and natural conclusion is that but for the assistance given to nature by man, the supply of the most important species of lake fish would have been so much reduced in a short time that no remunerative fishery could be supported, while this class of food would become a luxury attainable only by the rich, instead of being cheap and available to all.

This was the almost universal sentiment among those qualified to judge. This opinion has been fully substantiated in recent years, and notwithstanding the use of greater quantities of improved apparatus for the capture of fish, and much activity in fishing, the general verdict is that instead of a marked decrease in abundance, which might be expected under natural conditions, there has been a very noticeable increase in those regions where fish-cultural operations have been of sufficient magnitude and there has been time for the fish to reach maturity.

In the years succeeding 1885 fish culture has been carried on more extensively in the lake region, and an investigation of those fisheries now will doubtless show most fully the important influence which man can exert by breeding fish.

Partial returns for 1888 indicate a marked increase in the abundance of fish in localities where artificial propagation has been systematically carried on upon a large scale. This is especially noticeable in the fisheries of the western end of Lake Erie. In the region embraced between Toledo and Vermillion, and including those towns, together with Port Clinton, Sandusky, Bass Islands, and Huron, the increase in the quantity of fish taken in 1888, as compared with 1885, amounts to about 12,000,000 pounds, having a market value of over $300,000. In the case of whitefish the catch in 1888 in the region named was nearly as large as that of the entire lake in 1885.

The great consequence of this will be appreciated when the large and increasing numbers of people within easy reach of the principal lake markets are taken into consideration. At the present time they depend largely upon the lakes for a supply of fish food, and this dependence will increase in coming years with the growth of population.

6. COMPARISONS WITH 1880.

In the annual report of the Commissioner for 1884 it is stated that "it is now proposed to collect systematically the statistics of the fisheries of the Great Lakes in 1885, and to show by comparison with corresponding figures made by the Census of 1880 more accurately what the change has been, whether for the better or the worse."

With a view to present in as condensed a form as possible the comparative figures for 1880 and 1885, the following concise tables are presented, which show at a glance the changes that occurred between those years.

Reference to the table of men employed in the fisheries shows a net increase from 5,050 in 1880 to 10,355 in 1885, the increase being marked in Lakes Superior, Michigan, Huron, and Erie, while Lakes St. Clair and Ontario show a slight decrease.

The capital invested in the fisheries in 1885 exceeded by $3,174,106 that of 1880, the augmentation being shared by all the lakes. Particularly worthy of notice is the large increase in the number of steam fishing-vessels employed, especially on Lakes Michigan and Erie. The aggregate quantities of all the principal forms of apparatus were greater in 1885 than in 1880, although, to cite individual lakes, fewer pound-nets were operated in Lake Ontario, less gill-nets in Lakes Ontario and St. Clair, and fewer haul-seines in Lake Huron and Lake St. Clair than in the earlier years.

The yield of the fisheries, however, is the most interesting subject for comparison, and is particularly so at this time, since the figures must serve as a basis for deductions in future years as to the practical results of the artificial propagation of fish.

B.—*Table showing in detail the changes in the number of persons, vessels and boats, amount and value of apparatus, and capital invested in the fisheries of the Great Lakes from* 1880 *to* 1885.

Lakes.	Persons employed.		Steamers.				Vessels and boats.			
	Number.		Number.		Value.		Number.		Value.	
	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.
Superior	414	914	4	15	$9,400	$68,100	157	504	$16,840	$32,635
Michigan	1,578	3,378	30	82	63,400	267,600	806	1,320	69,975	100,726
Huron	470	892	3	10	7,000	41,300	108	551	13,905	31,646
St. Clair and tributaries	356	272	2	2	3,000	1,150	50	213	5,000	6,307
Erie	1,620	4,298	9	53	38,400	178,200	593	1,483	45,480	120,557
Ontario	612	600	1	2	3,600	4,800	166	465	9,500	15,648
Total	5,050	10,355	49	164	124,800	561,150	1,880	4,536	160,700	307,519

Lakes.	Pound-nets.				Gill-nets.				Haul-seines.			
	Number.		Value.		Number.		Value.		Number.		Value.	
	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.
Superior	43	230	$14,950	$67,520	4,630	7,557	$25,280	$78,082	32	43	$2,010	$2,920
Michigan	476	710	185,425	252,540	24,599	58,516	124,740	326,902	19	87	2,040	6,950
Huron	189	586	49,425	113,350	3,360	3,444	20,600	35,333	28	.....	5,600	.....
St. Clair and tributaries	.....	57	....	12,550	180	23	1,080	160	42	34	6,000	8,825
Erie	758	928	233,600	252,285	5,775	22,644	22,500	75,507	18	71	2,800	8,320
Ontario	34	14	14,000	6,975	6,000	4,722	20,000	23,952	9	69	1,950	3,177
Total	1,500	2,525	497,400	706,220	44,544	96,906	214,200	539,936	148	304	20,400	30,192

B.—*Table showing in detail the changes in the number of persons, etc.*—Continued.

Lakes.	Other apparatus of capture.		Shore property.		Total capital invested.	
	Value.		Value.		Value.	
	1880.	1885.	1880.	1885.	1880.	1885.
Superior	$200	$1,155	$12,700	$177,521	$81,380	$427,933
Michigan	1,455	13,757	104,100	788,356	551,135	1,757,831
Huron	3,500	23,100	3,700	140,620	103,730	385,349
St. Clair and tributaries	1,500	3,819	24,000	218,270	40,580	251,081
Erie	8,645	79,705	163,675	847,564	515,100	1,562,138
Ontario	....	25,097	5,000	56,100	54,050	135,749
Total	15,300	146,633	313,175	2,228,431	1,345,975	4,520,081

C.—*Table showing the variations in amount and value of fishery products on the Great Lakes from* 1880 *to* 1885.

Lakes.	Primary products.							
	Whitefish.		Trout.		Herring.		Sturgeon.	
	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Superior	2,257,000	4,571,947	1,464,750	3,488,177	34,000	324,680	....	182,760
Michigan	12,030,400	8,682,986	2,659,450	6,431,298	3,050,400	3,312,493	3,839,600	1,406,678
Huron	2,700,778	1,425,380	2,084,500	2,539,780	246,800	1,265,650	204,000	215,500
St. Clair and tributaries	77,922	41,125	....	....	250,700	1,208,150	998,500	227,780
Erie	3,333,800	3,531,855	26,200	106,900	11,774,400	19,354,900	1,970,000	4,727,950
Ontario	1,064,000	90,711	569,700	20,510	611,217	403,585	545,283	386,974
Total	21,463,900	18,344,004	6,804,600	12,586,665	15,967,517	25,869,458	7,557,383	7,147,642

Lakes.	Primary products—Continued.					
	All other species.		Total.		Value.	
	1880.	1885.	1880.	1885.	1880.	1885.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*		
Superior	60,875	258,216	3,816,625	8,825,780	$118,370	$291,523
Michigan	1,562,025	3,684,693	23,141,875	23,518,148	668,400	878,788
Huron	1,969,195	6,010,860	7,205,273	11,457,170	195,277	276,397
St. Clair and tributaries	523,805	708,740	1,850,927	2,185,795	36,273	40,193
Erie	11,982,900	23,734,912	29,087,300	51,556,517	474,880	1,109,096
Ontario	849,800	1,496,686	3,640,000	2,398,466	159,700	95,869
Total	16,948,600	35,894,107	68,742,000	99,842,076	1,652,900	2,691,866

Lakes.	Secondary products.								Total value of products.	
	Caviare.		Isinglass.		Oil.		Value.			
	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.	1880.	1885.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Galls.*	*Galls.*				
Superior	....	200	....	60	......	1,000	......	$415	$118,370	$291,938
Michigan	31,330	65,975	265	910	200	7,300	$6,985	9,634	675,385	888,422
Huron	....	....	....	....	......	1,500	......	450	195,277	276,847
St. Clair and tributaries	15,982	53,690	225	1,550	450	800	2,029	7,584	38,302	47,777
Erie	183,642	357,155	3,419	4,777	5,030	6,835	33,346	52,999	508,226	1,162,095
Ontario	....	....	....	....	......	......	......	......	159,700	95,869
Total	230,160	477,020	3,909	7,297	5,680	17,435	42,360	71,082	1,695,260	2,762,948

7. PRESENT CONDITION OF THE FISHERIES.

Considered as a whole, the fisheries on the Great Lakes were more prolific in 1885 than they had ever previously been. Individual fishing centers, and in one instance an entire lake, showed a diminution in the catch as compared with previous years, but the total output of fishery products and the total value received for the same were in excess of those of any other season so far as available records show.

This was due to several reasons. Among these may be mentioned the fact that more men were engaged in the fisheries than in any previous year, employing greater quantities of apparatus and adopting more improved methods of handling and preparing fish for market.

It was also believed that the effects of artificial propagation were beginning to be felt in some localities, and the increased abundance of fish made possible the profitable employment of additional quantities of apparatus.

The following detailed tables, which constitute a statistical summation of the report herewith presented, will convey a better and clearer idea of the extent of the Great Lake fisheries in 1885 than might be obtained from a more lengthy description:

D.—*Table showing the number of persons employed in the fisheries of each lake, together with those dependent upon them, in* 1885.

Lakes.	Fishermen.		Shoresmen and preparators.	Total.	Dependent on the foregoing.
	Professional.	Semi-professional.			
Superior	622	169	123	914	1,688
Michigan	1,914	1,140	325	3,379	7,009
Huron	663	156	73	892	2,140
St. Clair and tributaries	190	25	57	272	516
Erie	1,977	1,699	622	4,298	8,698
Ontario	264	297	39	600	1,143
Total	5,630	3,486	1,239	10,355	21,194

E.—*Table showing the amounts and value of apparatus, including vessels and boats, the value of shore property, and the capital invested in the Great Lake fisheries in* 1885.

Lakes.	Steamers.				Sail and row boats.					
	Fishing.		Collecting.		Gill-net boats.	Pound-net boats.	Sail-boats collecting fish.	Other boats.	Total.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*No.*	*No.*	*No.*	*No.*	*Value.*
Superior	10	$39,600	5	$28,500	189	94	4	217	504	$32,635
Michigan	70	216,900	12	50,700	429	352	8	531	1,320	100,726
Huron	7	27,300	3	14,000	42	150	15	344	551	31,646
St. Clair and tributaries	1	400	1	750	2	40	....	171	213	6,307
Erie	40	109,200	13	69,000	128	267	16	1,072	1,483	120,557
Ontario	......	....	2	4,800	171	7	6	281	465	15,648
Total	128	393,400	36	167,750	961	910	49	2,616	4,536	307,519

E.—*Table showing the amounts and value of apparatus, etc.*—Continued.

Lakes.	Apparatus of capture.											
	Gill-nets.			Haul-seines.			Traps.					
	No.	Length.	Value.	No.	Length.	Value.	Pound-nets.		Fyke-nets.		Other traps.	
		Feet.			*Feet.*		*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value*
Superior	7, 557	4, 280, 646	$78, 082	43	23, 020	$2, 920	230	$67, 520	12	$159	.....	.....
Michigan	58, 516	14, 919, 964	326, 902	87	55, 759	6, 950	710	253, 540	362	6, 105	1, 505	$330
Huron	3, 444	1, 764, 492	35, 333	....	....	....	586	113, 350	499	22, 910	.....	.....
St. Clair and tributaries	23	9, 400	160	34	13, 220	8, 825	57	12, 550	253	3, 590	.....	.....
Erie	22, 644	5, 877, 440	75, 507	71	42, 750	8, 320	928	252, 285	1, 069	62, 148	100	7, 500
Ontario	4, 722	1, 117, 309	23, 952	69	42, 644	3, 177	14	6, 975	1, 045	11, 594	336	12, 470
Total	96, 906	27, 969, 251	539, 936	304	177, 393	30, 192	2, 525	706, 220	3, 240	106, 506	1, 941	20, 300

Lakes.	Apparatus of capture—Continued.				
	Set-lines.			Value of spears, hand-lines, dip-nets, and trammel-nets.	Total value of apparatus of capture.
	Length.	No. of hooks.	Value.		
	Feet.				
Superior	215, 000	23, 500	$246	$750	$149, 677
Michigan	5, 596, 000	560, 400	5, 412	1, 910	601, 149
Huron	90, 000	10, 000	100	90	171, 783
St. Clair and tributaries	70, 200	7, 800	101	128	25, 354
Erie	4, 972, 000	504, 900	9, 652	405	415, 817
Ontario	550, 650	38, 610	488	545	59, 201
Total	11, 493, 850	1, 145, 210	15, 999	3, 828	1, 422, 981

Lakes.	Shore property.					Total capital invested.
	Value of buildings and wharves.	Value of fixtures and accessories.	Fish-cars.		Working capital.	
			No.	Value.		
Superior	$87, 325	$31, 171	125	$3, 150	$55, 875	$427, 933
Michigan	425, 190	87, 186	750	20, 760	255, 220	1, 757, 831
Huron	69, 199	13, 472	175	4, 699	53, 250	385, 349
St. Clair and tributaries	99, 600	10, 650	459	11, 520	96, 500	251, 081
Erie	472, 967	89, 798	520	8, 399	276, 400	1, 562, 138
Ontario	24, 090	5, 500	151	3, 010	23, 500	135, 749
Total	1, 178, 371	237, 777	2, 180	51, 538	760, 745	4, 520, 081

F.—*Table showing by species the quantities and values of fish taken, and quantities and values of manufactured secondary products prepared on the Great Lakes in* 1885.

Lakes.	White-fish.	Trout.	Herring.	Sturgeon.	Pike and pickerel.	Miscellaneous.	Total.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Superior	4, 571, 947	3, 488, 177	324, 680	182, 760	201, 404	56, 812	8, 825, 780	$291, 523
Michigan	8, 682, 986	6, 431, 298	3, 312, 493	1, 496, 678	675, 560	3, 009, 133	23, 518, 148	878, 788
Huron	1, 425, 380	2, 539, 780	1, 265, 650	215, 500	940, 500	5, 070, 360	11, 457, 170	276, 397
St. Clair and tributaries	41, 125	....	1, 208, 150	227, 780	230, 580	478, 160	2, 185, 795	40, 193
Erie	3, 531, 855	106, 900	19, 354, 900	4, 727, 950	16, 354, 065	7, 380, 847	51, 456, 517	1, 109, 096
Ontario	90, 711	20, 510	403, 585	386, 974	269, 265	1, 227, 421	2, 398, 466	95, 869
Total	18, 344, 004	12, 586, 665	25, 869, 458	7, 147, 642	18, 671, 374	17, 222, 733	99, 842, 076	2, 691, 866

F.—*Table showing by species the quantities and values of fish taken, and quantities and values of manufactured secondary products prepared on the Great Lakes in* 1885—Continued.

Lakes.	Manufactured products.				Grand total value of products.
	Caviare.	Isinglass.	Oil.	Total value.	
	Pounds.	*Pounds.*	*Gallons.*		
Superior	200	60	1, 000	$415	$291, 938
Michigan	65, 975	910	7, 300	9, 634	888, 422
Huron			1, 500	450	276, 847
St. Clair and tributaries	53, 690	1, 550	800	7, 584	47, 777
Erie	357, 155	4, 777	6, 835	52, 999	1, 162, 095
Ontario					95, 869
Total	477, 020	7, 297	17, 435	71, 082	2, 762, 948

8. FISHERY LEGISLATION.

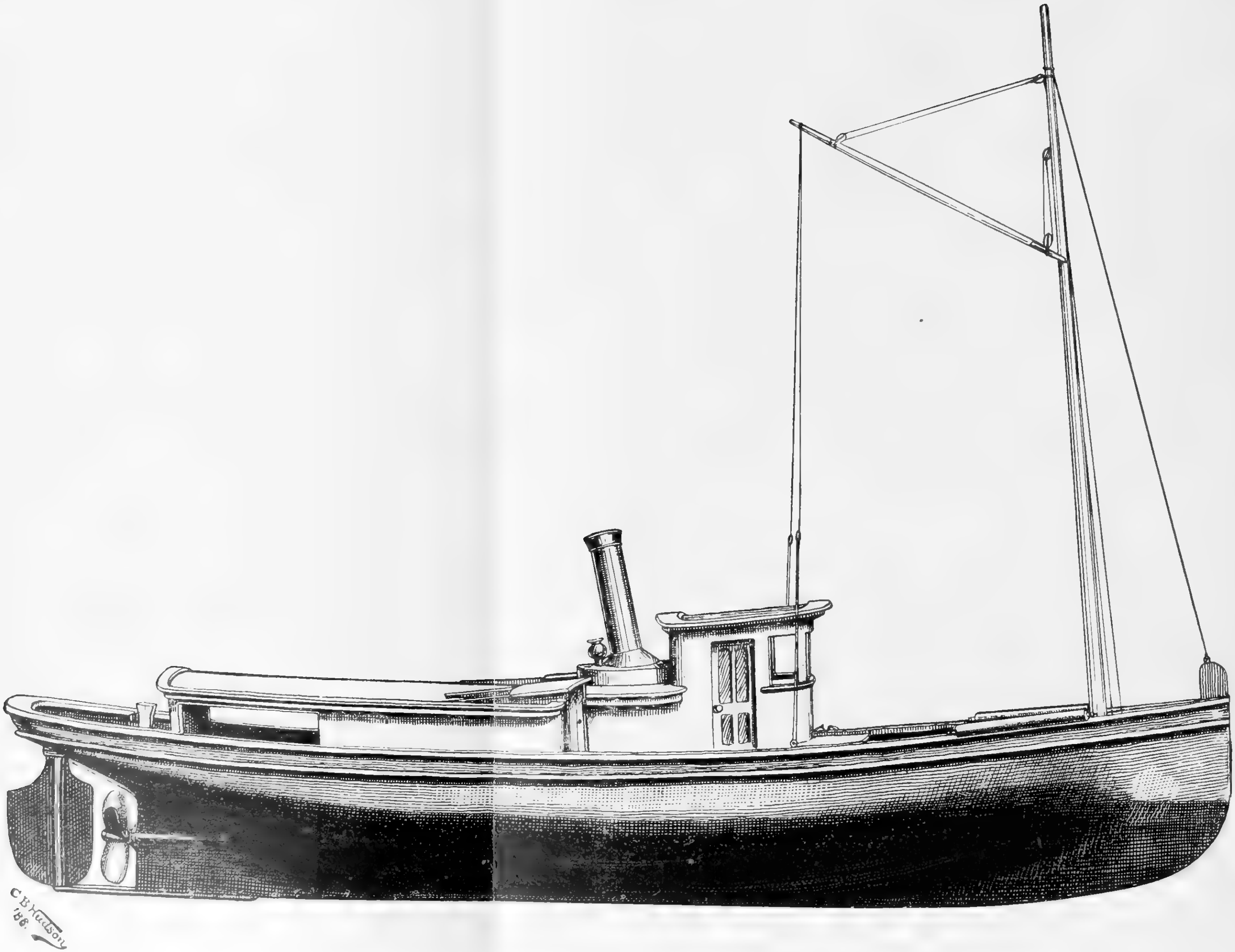
The marked diversity in the laws regulating the fisheries of the States bordering on the Great Lakes is a matter which appears to deserve consideration. The desirability of having some co-operative action on the part of the various lake states would seem to be apparent, in order that legislative enactments might have an equal bearing and influence upon the fisheries and the fortunes of the fishermen. Much dissatisfaction is often expressed by the latter concerning the inequality of laws governing the fisheries in regions immediately adjacent. It is only natural that the fisherman who finds his work interrupted and his enterprise defeated by restrictive measures should feel discontented when he sees his neighbor just across the state line prosecuting a similar fishery without hinderance. It is also, perhaps, an open question if any permanent benefit can be obtained by the enforcement of prohibitory measures by one state, when license is given to fishermen of neighboring states bordering upon the same lake to prosecute their calling without interference.

It is not the purpose of the writer to criticise special restrictions which have been put upon certain methods of fishing, but the object is more to call attention to the seeming inconsistency of attempting to control the fisheries of a lake by measures so widely at variance as those that are known to exist in the legislation of the different states that are interested in the lake fisheries.

9. CONCLUSION.

The foregoing will enable the reader to understand the motives that prompted the investigation upon which this review is based, and will at the same time convey certain information that could not well be given elsewhere, while it has thus been possible to show in a concise form the general features of the lake fisheries, so that the salient points can be seen at a glance. I trust this will at least meet with the approval of those who desire to know the leading facts and have no time for studying details.

J. W. COLLINS.



GILL-NET STEAMER. (See page 20.)

Drawn by C. B. Hudson from model in U. S. National Museum.

II.—VESSELS AND BOATS EMPLOYED IN THE FISHERIES OF THE GREAT LAKES.

By J. W. COLLINS.

The vessels and boats employed in the fisheries of the Great Lakes have certain peculiarities. In order therefore that their special characteristics should be clearly understood the following notes and illustrations are presented, these having been extracted from an unpublished report, prepared by the writer, on the fishing vessels of the United States.

10. FISHING STEAMERS.

At the present time there are employed in the fisheries of the Great Lakes a considerable fleet of screw-steamers. These vary considerably in size, form, and appearance. Generally, however, they resemble the ordinary tug used for towing, and are often spoken of as "fishing tugs." Some of them are employed chiefly in carrying to market the catch of the traps and pounds, and are usually referred to as "pound steamers;" others fish with large gangs of gill-nets, and are denominated "gill-net steamers." Occasionally they are used for towing like ordinary steam-tugs, and all are provided with a towing-post and cleats to which to fasten hawsers.

Vessels of this class are usually pretty sharp forward, have considerable sheer, straight and nearly vertical stem above water, curving sharply below to join the keel, and a round overhanging stern. As a rule, the midship section is full and rather flat on the floor, but some of the smaller steamers are sharp on the bottom. The differences in this respect are shown in the illustrations, Plates 1–3. The boiler and steam-engine are located nearly amidships, and are covered by a deck-house, forward of which is the pilot-house. The smaller steamers do not usually have any cabin, but some of the larger boats are better provided. In some cases the deck-house is extended aft of the engine-room, and is used for the storage of nets or other material. But some of the steamers have their nets stowed at the stern, where the deck is raised for the purpose of affording additional accommodations.

The gill-net steamers are provided with rollers upon their bows, as shown in the illustration, Plate 2.

The fish are commonly stowed in the hold forward of the engine-room,

access being had to this through a large hatchway located just in front of the pilot-house. It is often the case, as at Cheboygan, Michigan, that the steamers are provided with pens and ice-boxes in the hold, into which the fish are put.

When the gill-nets are hauled they are stowed below, just as they come from the water; two men stand on an elevated platform in the hatchway to receive and coil away the nets in the hold.

The lake fishing steamers generally have a single mast that stands forward of the pilot-house, with a stay set up at the stem head. Sails are seldom used, however, but the gaff attached to the mast chiefly serves the purpose of a derrick, having a tackle attached to it, by which fish-boxes, etc., are hoisted in and out of the vessel.

The illustration, Plate 1, is from a model in the National Museum at Washington, and represents a type of fishing steamer that is used quite extensively in the lake fisheries. This is sharp on the floor, sets pretty low in the water, and is considerably deeper than the majority of vessels of this class. The steamer represented by the model referred to has the following dimensions:

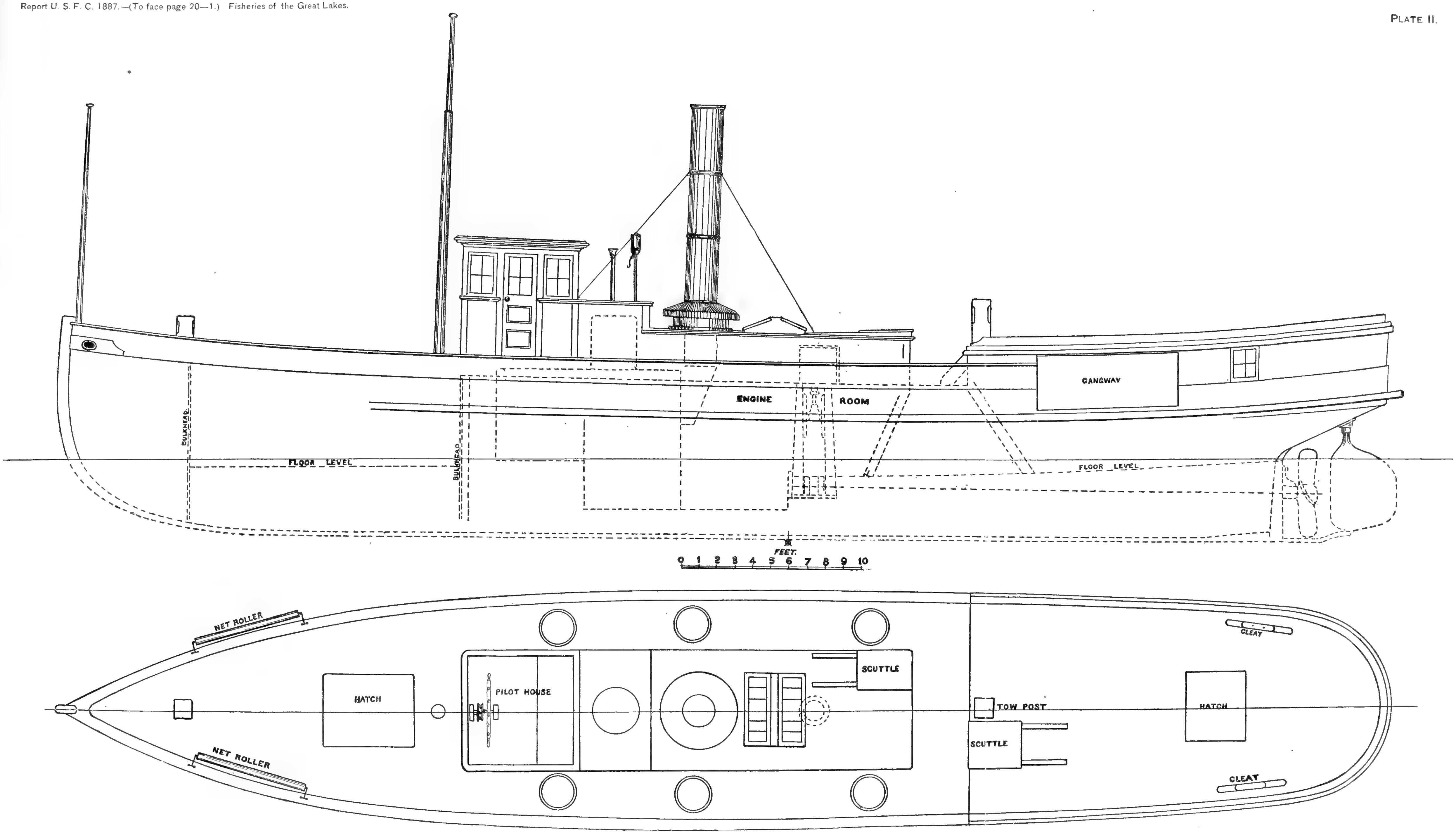
Length over all, 61 feet; beam, extreme, $11\frac{1}{2}$ feet; draught, aft, $5\frac{7}{12}$ feet; mast, above deck, 34 feet; length of gaff, $15\frac{1}{2}$ feet.

The illustrations, Plates 2 and 3, of the sheer plan, deck plan, and cross-sections of the lake fishing-steamer *T. R. Merrill*, built in 1875, were furnished the writer by Mr. Frank E. Kirby, consulting engineer of the Detroit Dry Dock Company. This represents the type of steamer most commonly used for lake fishing. As will be seen, she has a full midship section, rather flat floor, moderate sheer, and high freeboard in ordinary ballast trim. She has a raised deck or poop aft for about one-third the length of the vessel, which affords additional capacity in that section. The mast in this vessel is short, and is apparently used only as a support to the gaff, upon which the hoisting tackle is suspended. A small flag-pole stands at the bow. The frame and planking are white oak; deck and deck-houses white pine. She steams 10 miles per hour. The following are the principal dimensions:

Length over all, 75 feet; length on calculated water-line, 68 feet; beam, extreme, $13\frac{1}{2}$ feet; depth, molded, $7\frac{1}{2}$ feet; depth of hold amidships, 7 feet; draught, aft, $4\frac{7}{12}$ feet; height of mast above deck, $20\frac{1}{2}$ feet.

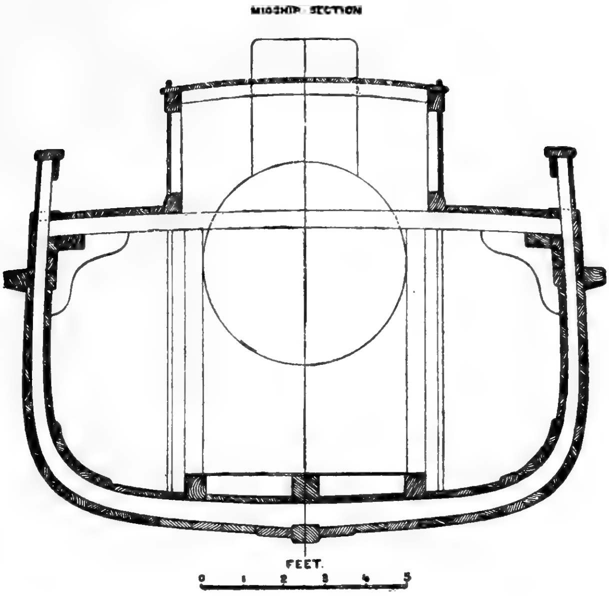
The following are some of the principal details of the steam-tug *Erwin*, of Sandusky, Ohio, which was built for fishing with gill-nets.

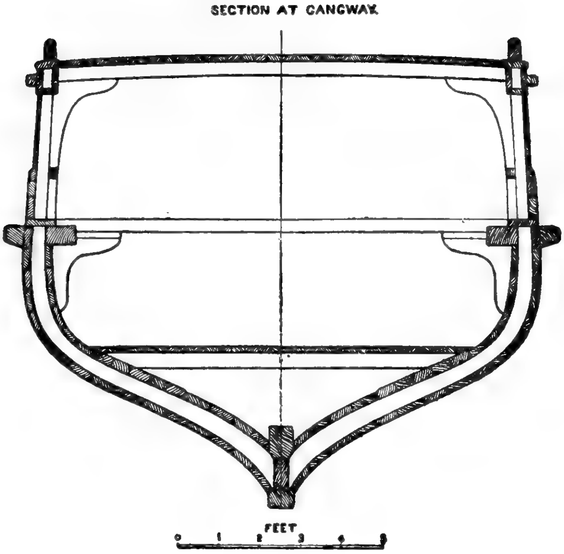
In general appearance she resembles an ordinary tug, with sharp bow, stem straight and nearly plumb above water, strong sheer, round stern, and deck-houses (including pilot-house) raised considerably above the deck. There is a "break" at the after end of the engine-house, the stern portion of the deck being $11\frac{1}{2}$ inches higher than that forward of it, and only 8 inches below the top of the rail. The elevation of the after deck apparently serves a double purpose; there is more room be-



SHEER AND DECK PLANS OF FISHING STEAMER T. R. MERRILL. (See page 20.)

Drawn by Frank E. Kirby.





CROSS-SECTIONS OF FISHING STEAMER T. R. MERRILL. (See page 20.)

Drawn by Frank E. Kirby.

low at the stern of the little tug, and a better opportunity to stow the boxes of nets above deck aft, so that the apparatus can be set more readily than otherwise might be the case.

In this after deck are two small hatches or scuttles, through which access can be had to the hold beneath.

The *Erwin* is 16.95 tons gross tonnage, and 8.48 tons net. She draws from 6 to 7 feet of water, and is sharp on the floor.

She is propelled by a screw; has a 10 by 12 non-condensing high-pressure engine; steel boiler 8 feet long by 4 feet diameter; pressure, maximum, 105 pounds to the square inch; speed, 10 miles an hour. She has no mast and no sail power. Cost, $3,500.

11. HURON BOAT.

A special form of two-sail schooner-rigged boat, called the "Huron," and sometimes the "Hayward boat," is used in the fisheries of the Great Lakes, and may be found at many of the lake ports, particularly at Michigan City, Indiana, and at Mackinac, Saugatuck, South Haven, and St. Joseph, Michigan. In 1872–'73, according to Milner, it was in greatest favor where the large gill-net rigs were used.

This is an open keel boat, moderately sharp forward, with a round bilge, rather short run, no overhang to counter, and a deep, heavy, heart-shaped, square stern, with the rudder hung outside. It has less sheer than the Mackinaw boat, and more room for nets, fish, half-barrels, etc. The foremast stands as far forward as possible, and is usually longer than the mainmast. The length of boats of this type is commonly from 30 to 40 feet, with a beam of about 8 or 9 feet. A boat 32 feet long and 8 or 9 feet wide would have a tonnage of about 5 tons. The best boats of this build have the reputation of being faster sailers than those of the Mackinaw type, and are used for fishing much farther from the shore, in deeper water. They are employed to a very large extent on Lake Michigan and also on the other lakes where large gill-net rigs are operated; they are not, however, so numerous elsewhere as on Lake Michigan.

These boats have been noted for the many disasters which have occurred to them, and the consequent great loss of life. We are not clearly informed as to whether this is due to any fault in the boat itself, or lack of seamanship in the fishermen, or because of the peculiar dangers to which both boats and men are subjected in the prosecution of the fisheries in that region. The only explanation of it we have seen is that by Milner, who says:

"An inquiry into the history of loss of life and accidents among the fishermen of Lake Michigan indicates that these boats had suffered the most, partly, no doubt, because of their longer runs out from shore."

12. MACKINAW BOAT.

A type of sharp-sterned, and commonly schooner-rigged, boat is employed in the fisheries of the Great Lakes to a considerable extent, and this has received the distinctive name of "Mackinaw boat." It derives its typical name from the island and strait of Mackinaw, where it was first employed, and though, in recent years, it has been adopted in the lake fisheries over a much wider region, the name of the locality where it originated has always been applied to it. In its general features it is closely allied to the "pinkie" boats of the Atlantic coast, though differing in detail; it most nearly, perhaps, resembles the sharp-sterned small craft on the coast of Maine.

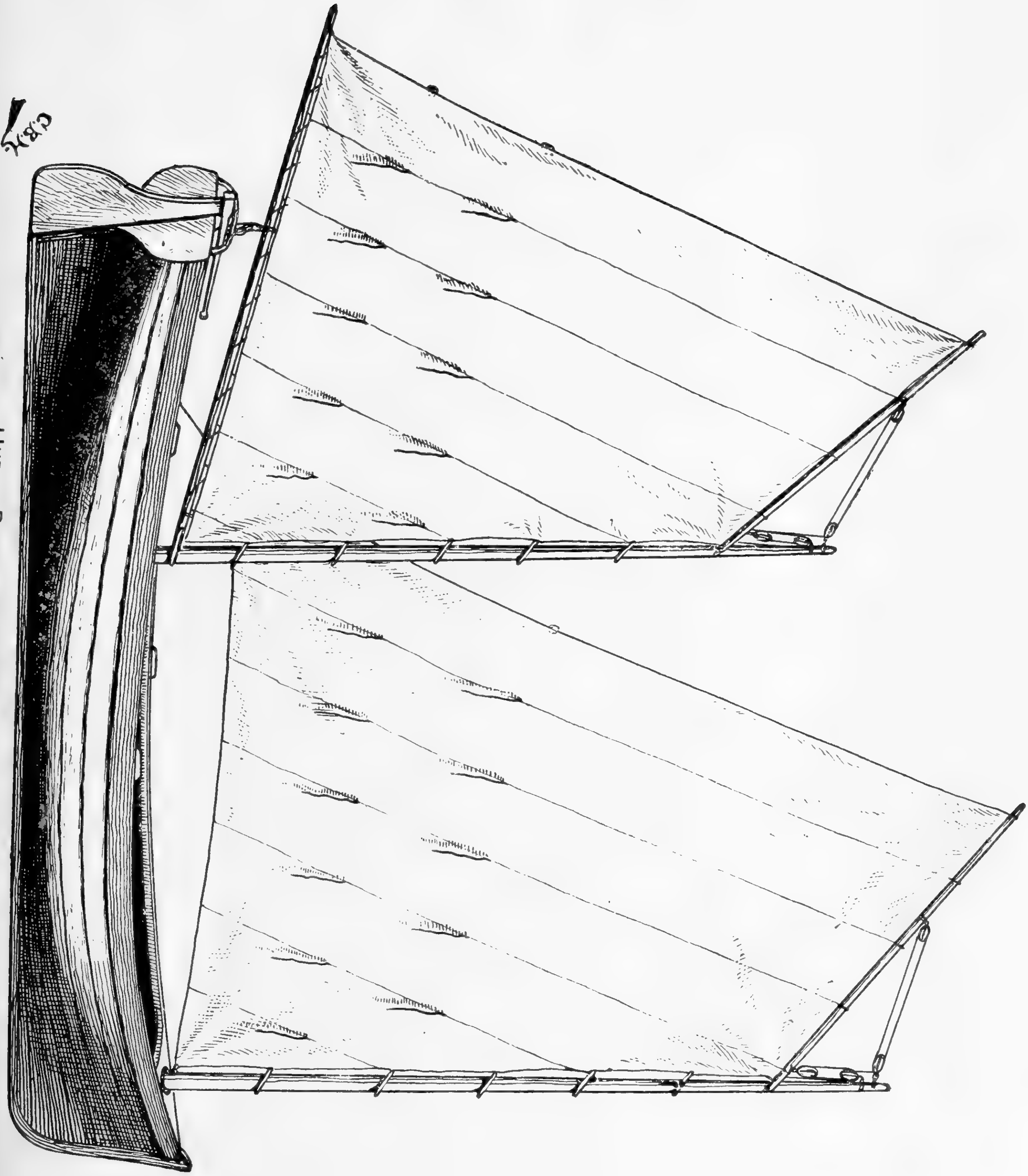
It is an open boat, generally provided with center-board, has sharp ends, the bow being much fuller than the stern, which is remarkably fine, while the midship section is round and sometimes "bulging." Some of the boats are carvel-built, while others are lap-streaked, and they have a strong sheer. The prevailing rig is that of a schooner, with jib, loose-footed gaff-foresail, and boom and gaff-mainsail, but sometimes a lug-sail is carried, and a sloop rig is in favor in some localities. Those employed at Escanaba, in Green Bay, Michigan, have a schooner rig, with three sails, but from Peshtigo River to Cedar River, south of Escanaba, small sloops similar to, but not true, mackinaws are used.

Milner,[1] writing of the mackinaw boat, says:

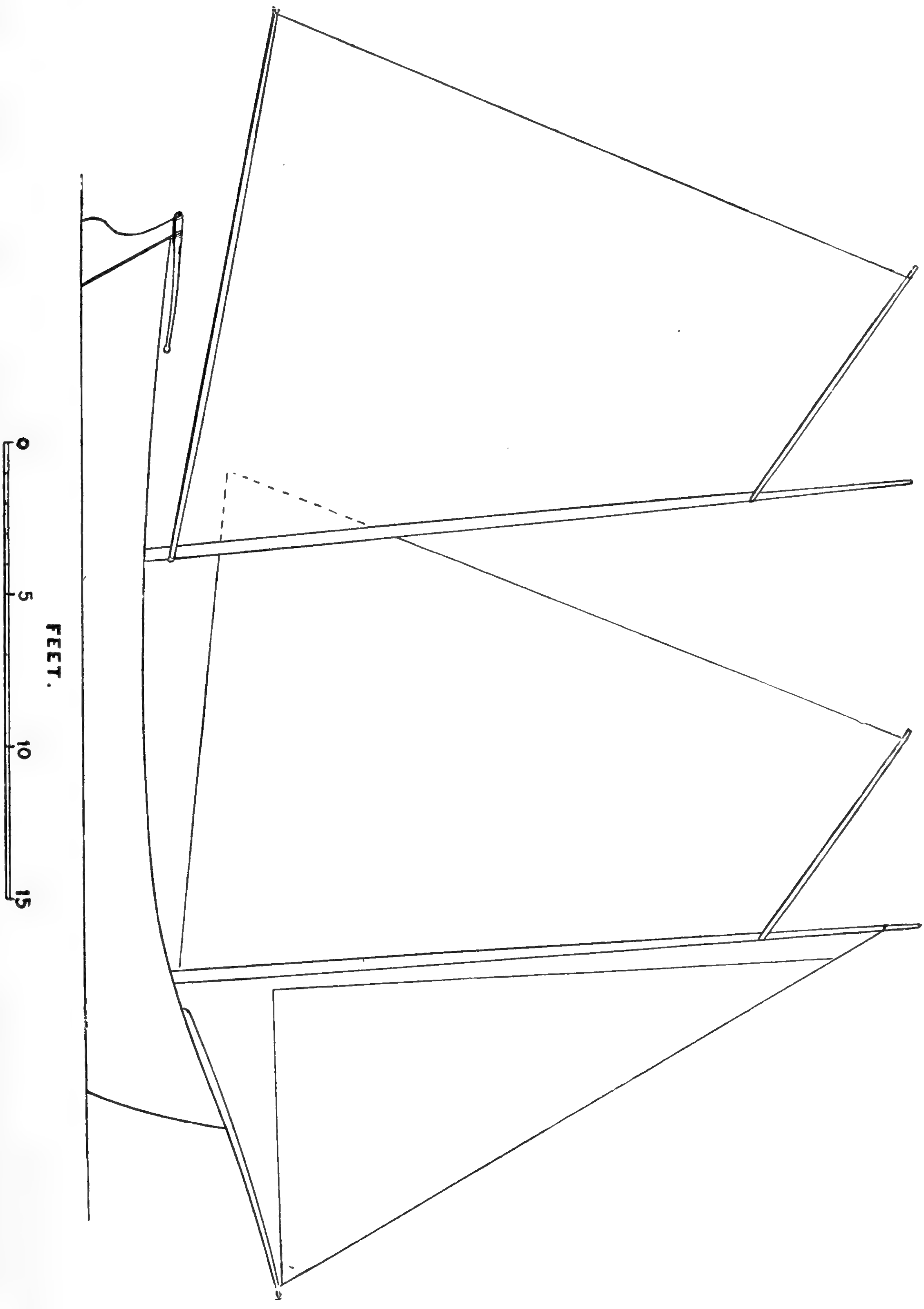
"She is either schooner rig or with lug-sail forward, is fairly fast, the the greatest surf-boat known, and with an experienced boatman will ride out any storm, or, if necessary, beach with greater safety than any other boat. She is comparatively dry, and her sharp stern prevents the shipment of water aft when running with the sea. They have been longer and more extensively used on the upper lakes than any other boat, and with less loss of life or accident. The objection to the more general use of the mackinaw is that her narrowness aft affords too little room for storage. They are employed entirely with the light-rig gill-net stocks, and are usually from 22 to 26 feet in length. Lake Superior, the northern half of Lake Michigan, and a large portion of Lake Huron are the regions where they are in general use."

Mr. R. E. Earll has furnished the measurements and other details of the boat *Jennie Gilbert*, of Escanaba, Michigan. This boat is carvel-built, with a shallow keel (about 4 inches deep) and center-board. Like all of her class, she has a sharp bow and stern, the greatest beam nearly amidships. The bow is rather full and convex above water, particularly at the gunwale, but is much sharper below; the sides well rounded and "almost bulging in the middle," while the stern and run taper gracefully, the after section having remarkably easy lines. The stem

[1] James W. Milner, Report U. S. Commissioner of Fish and Fisheries for 1872 and 1873, part II, p. 13.



HURON BOAT. (See page 21.)
Drawn by C. B. Hudson.



SAIL PLAN OF MACKINAW BOAT. (See page 22.)

Drawn by J. W Collins

is nearly straight and almost vertical; the stern-post is straight and rakes about 6 inches. She is provided with wash-boards about 6 inches wide, these having a low coaming along their inner edge some 1 or 2 inches high, to prevent water from running into the boat.

At the bow there is a sort of half-deck or platform, on a level with the thwarts, running back to the foremast, a distance of about 4 feet. There are two thwarts in the middle or "body" of the boat, these being separated about 9 or 10 feet. Between these thwarts is the fish-room, and here also is stowed the ballast, the latter being put into the after part of the compartment, while the forward part is reserved for the storage of fish. Underneath each thwart is a bulk-head extending crosswise of the boat, and separating this fish and ballast room from the forward and after standing-rooms or "pits." The middle compartment is divided longitudinally by the center-board case, which is 8 feet long, and the after end of which touches the forward side of the after thwart. An adjustable board platform is laid on each side above the thwarts; the object of this is to protect the fish from the sun's rays, which would burn and injure them, and also for preventing the too rapid melting of the fine ice that is thrown over them while they are being carried to market from the fishing-ground.

Between the half-deck at the bow and the forward thwart is a standing-room or so-called "pit," having a platform or flooring for the boatmen to stand upon, and abaft the after thwart is a similar compartment, with a scuttle in its floor covering the "bailing well," while at the stern is a permanent seat for the helmsman to sit upon. The rudder-head rises above the stern-post, as is common in this class of boats, and is operated by a long wooden tiller.

This boat is schooner-rigged, has long tapering masts, a moderately long bowsprit, and carries a large area of canvas. The foremast is supported by a single shroud on a side, and by the jib-stay; it steps at the after edge of the forward platform or half-deck, and the mainmast stands at the after side of the after thwart. The main-boom extends about 7 feet behind the stern-post. In principle the masts are adjustable, but in boats of this size they are too heavy to be easily handled, and are seldom unshipped.

Three sails are carried, namely, a jib, which sets on a stay, a loose-footed gaff-foresail, and a boom and gaff-mainsail. The mainsail and foresail are bent to mast hoops.

Although the boat, like others of the same type, depends chiefly on sails for propulsion, she has rowlocks just forward of amidships for two oars, and when there is a calm the boatmen can sit on the forward thwart to row, but quite frequently they stand up abaft the oar and "push," a favorite method of rowing with many fishermen who sail on large open boats.

The following are the dimensions and cost of the *Jennie Gilbert:* Length, over all, 28 feet; beam 7 feet 6 inches; draught, in ballast trim,

with center-board up, 22 inches; with center-board down, 6 feet; length of masts, each, 28 feet; bowsprit, outside stem, 6 feet; main-boom, 18 feet; main-gaff, 9 feet; fore-gaff, 8 feet. Cost, $320.

The boats used at Sack Bay, near Fayette, Michigan, on Bay de Noquet, Lake Michigan, are both clinker and carvel-built, with esssentially the same form and rig as that last described. The Sack Bay craft, however, have their mainmast a little shorter than the foremast; the wash-boards are 5 inches wide in the middle and taper to 2 inches at the stern. The wash-boards are provided with the usual coaming on the inside, and some of the boats have, in addition, a bow-chock or wash-strake 3½ inches high around the bow and extending aft from it for a distance of 9 feet on each side, its purpose being to keep off the spray or swash when the boat dives in a seaway.

The following are about the average dimensions of the boats of this region: Length over all, 26 feet; beam, 6 feet 6 inches; stem to forward thwart, 7 to 8 feet; after thwart to stern-post, 11 feet; length of center-board case, 4½ to 5 feet.

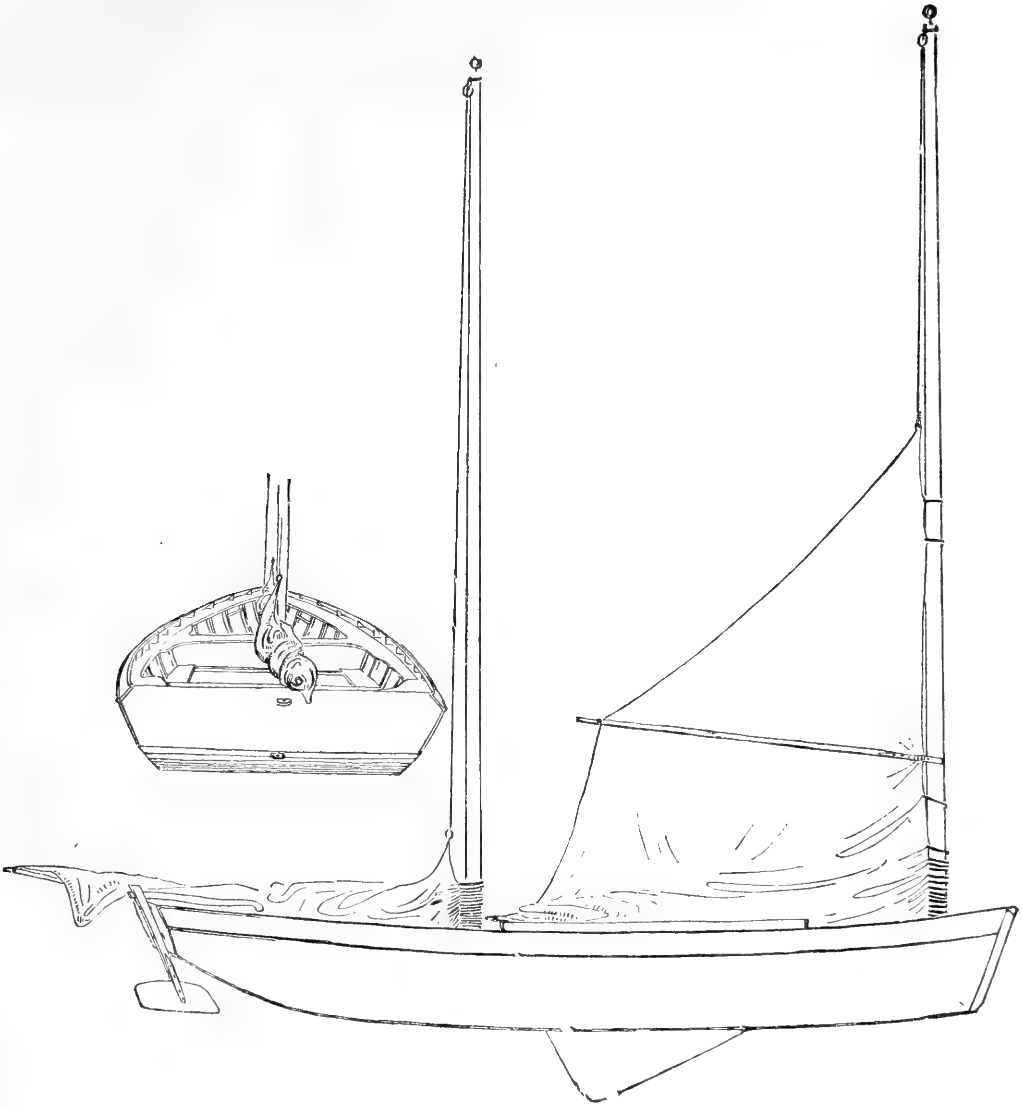
At Duluth, Minnesota, the mackinaw boats average about 32 feet in length; at Bayfield, Wisconsin, 25 feet; and at Marquette, Michigan, 30 feet.

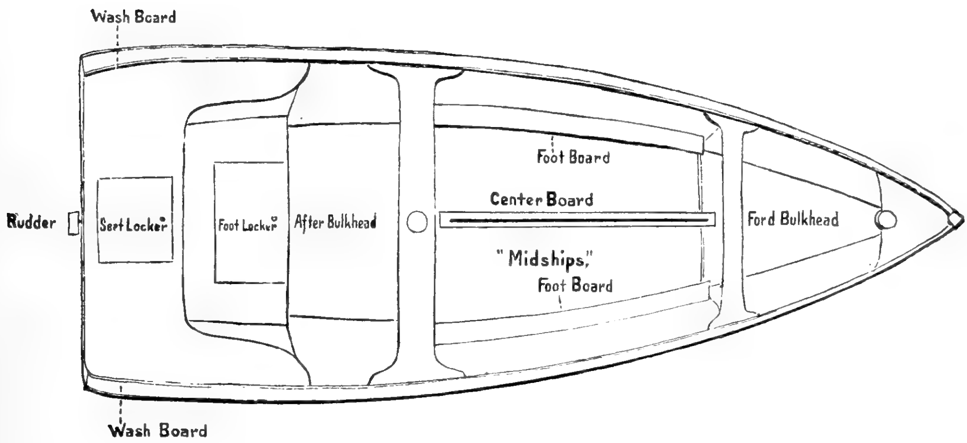
13. NORWEGIAN BOAT.

In some localities on the lakes, particularly at Grand Haven, St. Joseph, and Michigan City, a peculiar type of sloop or cutter-rigged boat is employed by natives of Norway and Sweden, who naturally prefer to use craft similar to those they were familiar with in Europe. Among the fishermen this is known as the "Norwegian boat," for the twofold reason that in form, construction, and rig it resembles the fishing boats of Norway, and that it is used exclusively by Scandinavians. Its non-adoption by American or other fishermen is because they consider it too heavy and unwieldy in calm weather, when rowing must be resorted to. Thus, although it sails well in a fresh breeze and is far superior in sea-worthiness to any other boat on the lakes, all the fishermen, except those from northern Europe, prefer a center-board boat that is lighter in construction, which will sail better in light winds, and is easy to row in calm weather.

"At Grand Haven," says a writer, "we find all 'heavy rigs.' The sail-boats used are the huge, clumsy Norwegian sloops, from 30 to 40 feet in length, with 10 feet beam, and carrying 200 yards of canvas. They are the safest and driest boats used on the lakes, and, by their owners, pronounced the fastest as well, as they assert they can easily pass the lake schooners with them. Even those using the Hayward or Huron boat speak in the highest terms of the Norwegian."

The "Norwegian" is usually a sharp-stern keel-boat, with strong sheer, hollow floor near the keel, and more or less concave water-line forward and aft. In recent years it is sometimes built with a narrow





PLANS OF TYPICAL POUND-NET BOAT. (See pages 25 to 27.)

Drawn by Henry W. Elliott.

square stern, and occasionally it is fitted with a center-board. This is especially the case about Milwaukee.[1]

Its construction varies in other particulars, some boats being carvel-built, while in others the planks lap over each other. Most of those at Grand Haven are lap-streaked or clinker-built, while the opposite is true at Milwaukee. In all cases, however, it has the hollow floor, which is such a characteristic feature of the fishing-boats of Norway and Sweden.

It is usually half-decked forward and aft—sometimes decked only at the bow—with wash-boards along the sides.

The frame is of white oak, the plank of white oak, but exceptionally of pine, the deck at each end and the wash-boards are usually pine, and the fastening is wrought-iron, well riveted on inside.

The rig is that of a sloop or cutter, a boat having one mast and usually carrying three sails, mainsail, forestay-sail, and jib. The jibs are generally set flying without a stay, and sometimes a boat will have two sizes of jibs, a large one for moderate winds and a small one for heavy weather. Sometimes a gaff-topsail is used in light winds.

The cost varies, according to the best authorities, from $300 to $1,000. The average would be about $600. Captain Coffy thinks the average cost will not exceed $325.

The dimensions vary from 25 to 35 feet in length. The following figures have been obtained from three places:

Grand Haven, Michigan:		
Length	feet	25 to 30
Extreme beam	do	9 to 11
Length of mast	do	25 to 30
Diameter of mast	inches	7 to 9
Length of bowsprit, outboard	feet	14 to 16
Racine, Wisconsin:		
Length, over all	feet	25 to 30
Beam	do	9 to 11
Length of mast	do	24 to 28
Diameter of mast	inches	8
Bowsprit, outboard	feet	12 to 16
Milwaukee, Wisconsin:		
Length, over all	feet	35
Beam	do	8½
Depth	do	3½
Hoist of mainsail	do	20

These boats usually carry from three to five men, but sometimes as many as six.

14. POUND-NET BOAT.

For attending the pounds on the Great Lakes there are employed a large number of schooner-rigged boats, which in shape more or less closely approximate to the form of the sharpie. There appear to be

[1] One who has sailed in these boats says that those which are sharp aft are better than the square-stern class, especially when fishing or running in a heavy seaway.

three styles of boats used in the pound-fishery, one of which—that employed on parts of Lake Erie—according to Mr. H. W. Elliott, closely resembles in the shape of its hull the Connecticut sharpie; another is wider, more clumsily built, and in form may be classified as of the flat-iron shape; the third kind of pound-boat is built of rough boards, and shaped much like the others, but is propelled by oars only or towed.

As has been said, these boats more or less closely resemble the New England sharpie, and this is doubtless due to the fact that the pound-fishery on the lakes was established by the fishermen from that section who were familiar with the sharpie and found it well adapted to their work on these inland seas.

The local variations in size, rig, etc., have been briefly summarized by Mr. Kumlien in the following notes written in 1880:

Lake Superior.—Bayfield, Wisconsin, the ordinary flat-bottom boats.

Lake Michigan.—Escanaba, Michigan, scow-like, flat bottoms, and carry large loads; west shore of Green Bay, Peshtigo River to Cedar River, average 22 feet in length, 7 feet beam, mast set in the bows like mackinaws, bins extend entire length, steered by a long oar. Other portions of west shore of Green Bay, average 28 feet in length, masts long and heavy; Two Rivers, Wisconsin, average 24 feet in length; Michigan City, Indiana, sloop-rigged; Petoskey, Michigan, and vicinity, some have no sails and others are rigged like a mackinaw; Mackinac, Michigan, same as those used at Petoskey.

Lake Erie.—Huron, Ohio, average 30 feet in length, 10 feet beam, carry from 7 to 10 tons, have 35-foot masts; Vermillion, Ohio, 30 feet long, 12 feet beam, masts 40 feet; Amherst and Brownhelm, Ohio, 25 to 32 feet in length, 7 to 10 feet beam, 2½ to 3 feet deep, two masts and gaff-topsail in same sheet as mainsails, no jibs, rowed in rough weather. Dover Bay, Ohio, from 20 to 26 feet long, 7 to 9 feet beam; Painesville and Willoughby, Ohio, from 28 to 34 feet long, 8 feet beam, 4 feet deep, two masts.

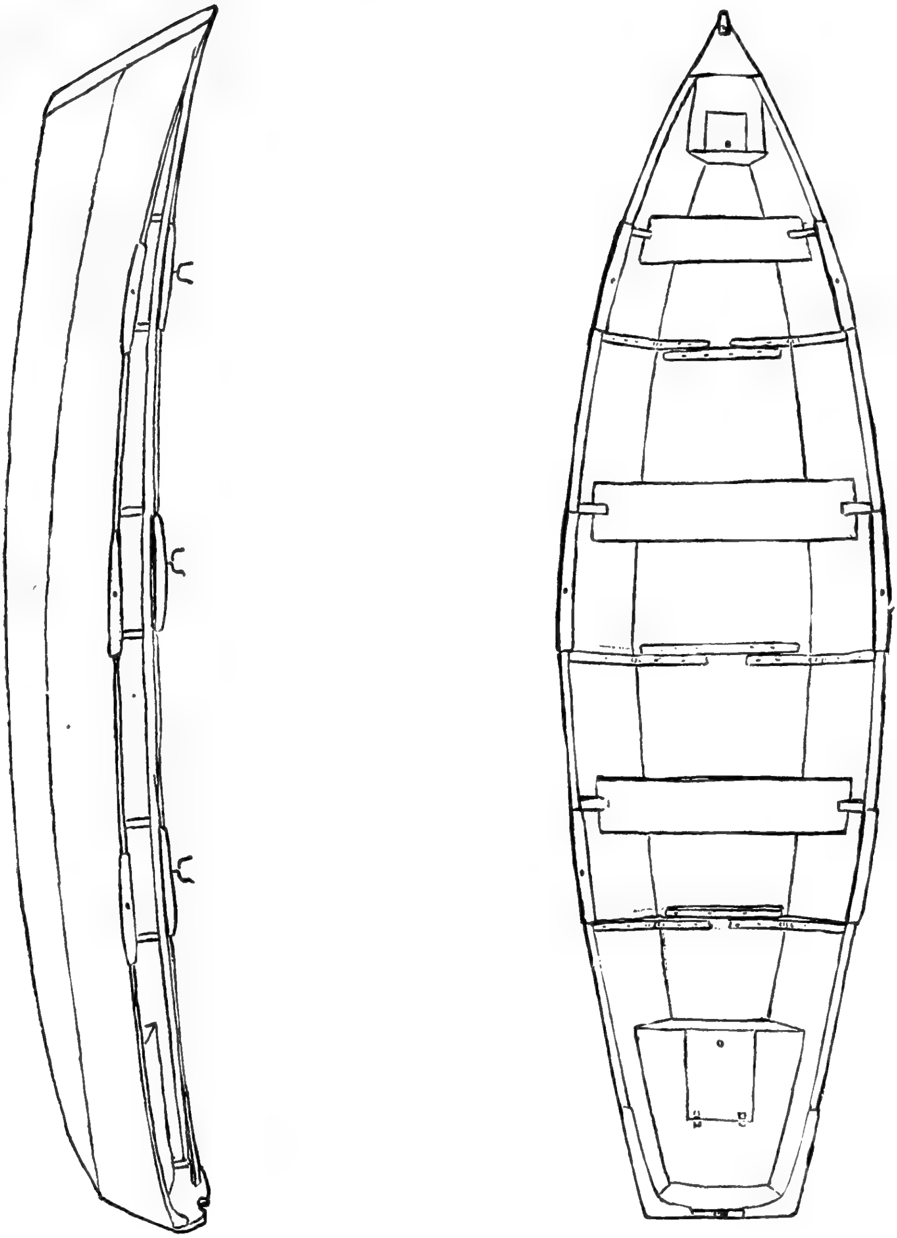
The pound-boats used at the Big Point Sable fisheries, Lake Michigan, do not differ from those employed in other sections except, perhaps, that they are a little larger and somewhat more substantially built, as they are often exposed to very severe storms.

The pound-boat ordinarily used may be thus described: It is an open, flat-bottomed, carvel or clinker built boat, with a sharp bow; slight flare to sides; a good deal of camber to the after part of the bottom, and a wide, square stern. It is not provided with a skag; the rudder is hung to the stern, below which it extends. Commonly, the rudder is simply a piece of board set into a slot in the lower part of the rudder head and projecting nearly as much forward as it does aft.

"One of the leading peculiarities," says a writer, "is its steering apparatus, which consists of a board placed crosswise in a sawed groove at the bottom of the rudder-post, forming a sort of a cross with arms of unequal length. One of these arms extends from 2 to 3 feet forward

CLEVELAND POUND-NET BOAT, UNDER SAIL.

Drawn by Henry W. Elliott.



PLANS OF POUND-NET DINGHY. (See page 28.)

Drawn by Henry W. Elliott.

of the post and the other 4 to 5 feet aft of it. The board which forms the rudder is from 10 inches to a foot in width perpendicularly, and 5 to 7 feet long."

The object of this contrivance is to obtain as much force as possible with the small immersion which the rudder has. The pound-boat has a large center-board; there are two thwarts, one of which is placed at each end of the center-board, and two bulk-heads, one under the forward thwart and one about 2½ to 3 feet aft of the after thwart. Between, these is the fish-room, into which the catch is thrown when taken from the pound-nets.

It is necessary to have a wide boat in order to secure the stability which is required for lifting the cribs or pockets of the pounds and it is also desirable to have a boat for this work which will carry a large load of fish on a very small draught of water. These boats are roomy and well adapted to transporting fish from the nets to the packing and freezing houses, and it is also claimed that they are fast sailers, particularly when running before the wind. Of course, one familiar with boats would readily understand that they could not sail very rapidly close-hauled by the wind, especially if there was any sea on. Their flat bottom and light draught cause them to pound so heavily in rough water that they can not work to windward against a high sea with any success.

The pound-boat has two tall, tapering masts. The foremast is stepped close to the stem, while the mainmast is placed at the after thwart, which, in a 40-foot boat, would be 16 or 17 feet forward of the stern. Two sails are carried. The foresail and mainsail are both provided with a boom, as a rule. The peculiarity of the rig of the pound-boat is that the sails are made to insert between a double gaff, so that when hoisted up by a single halyard to the masthead either of the two sails has the appearance of being divided into two parts, the upper being triangular and resembling a gaff-topsail.

The relative proportions of a pound-boat, such as are used at the western end of Lake Erie, are as follows:

	Ft.	In.
Length, over all	24	9
Beam, extreme	9	6
Width of stern	7	0
Width of bottom, amidships	7	4½
Depth, amidships	3	0
Depth of stern	2	3
Depth of bow, with rake of stem	3	7½
Length of center-board case	5	1
Foremast, above gunwale	23	0
Mainmast, above thwart	21	6
Fore-boom	12	0
Fore-gaff	8	6
Main-boom	11	0
Main-gaff	7	0

Mr. Elliott gives the following as the dimensions of the pound-boats used in the vicinity of Cleveland, Ohio:

Length	feet..	28 to 31
Beam	do...	8 to 11
Depth	do...	$2\frac{1}{2}$ to $3\frac{1}{2}$
Tonnage	tons..	$4\frac{1}{2}$ to 7
Area of foresail, about	yards..	75
Area of mainsail, about	do...	60

The Cleveland boat, as represented in Plate 7, is not so wide aft, nor so clumsy as the ordinary form represented in Plate 6.

The pound-boats in use at Waukegan, Illinois, have no wash-boards and no sails. They have the usual flat bottom, sharp bow, slight flare at the sides, and broad, square stern. The ribs are natural-growth hard-wood knees, and between each frame is a cross-piece on the bottom, from side to side.

These boats are fitted for rowing, but ordinarily they are towed to and from the pound-net by horses; oars are seldom used except to shove off to the traps after the position of the net is reached, and in like manner return to the shore.

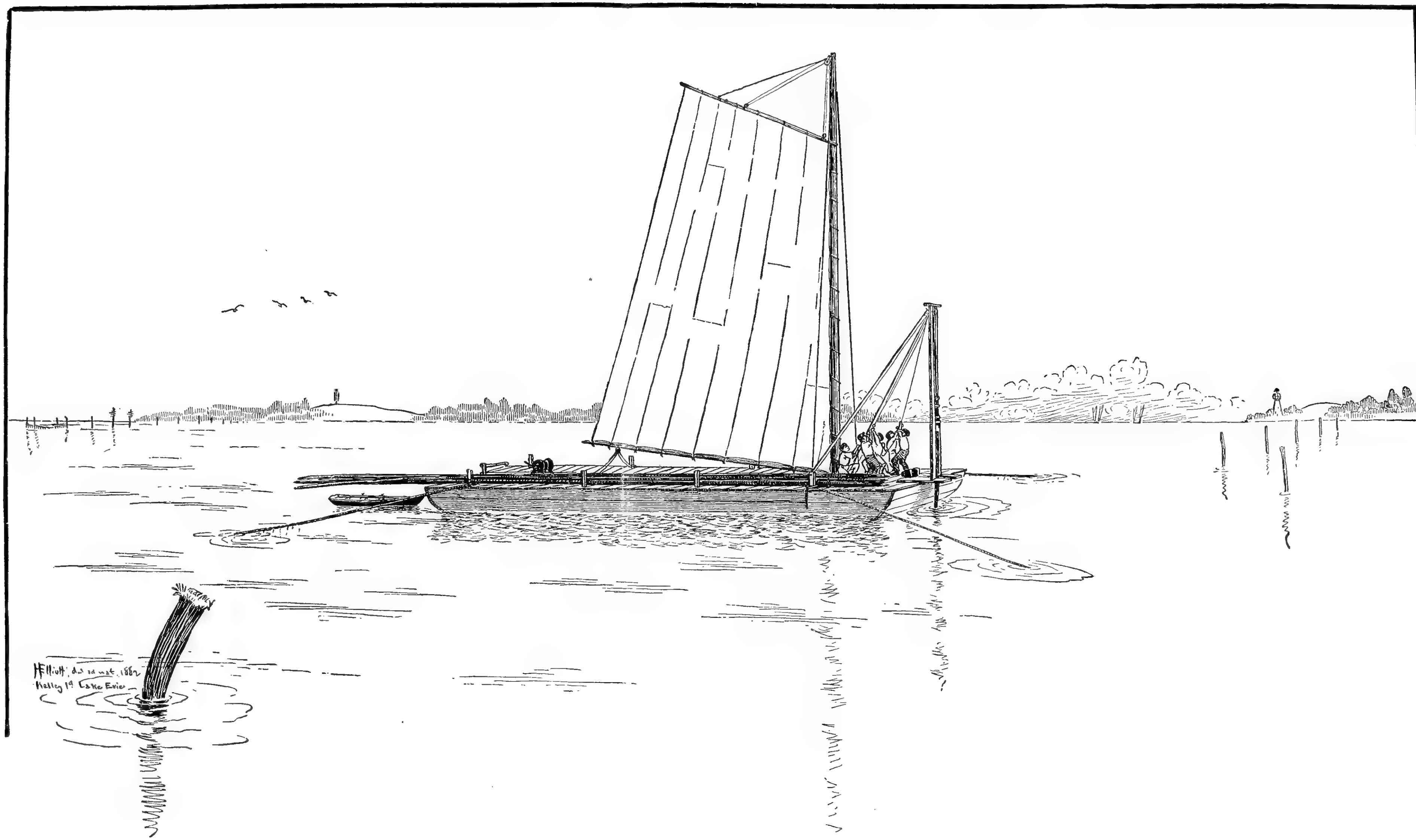
Some of the pound-nets are as much as 7 miles from Waukegan, where the catch is marketed. Starting out in the morning, a horse is attached to a long tow-rope, and one man steers the boat with an oar, keeping her far enough off from the beach to prevent her from grounding, and also to keep the rope in the water so that it will not drag on the beach.

One of the boats had the following dimensions: Length, 25 feet; beam, 8 feet; curve of bottom, 6 inches.

A pound-boat seen by Mr. Earll at the fishery of A. Booth, Bark River, south of Escanaba, Michigan, was a little over 24 feet long, and about 7 feet beam, the stern was $4\frac{1}{2}$ feet wide on top, and $3\frac{1}{2}$ feet wide on the bottom. It had the common flat bottom, sharp bow, with raking stem, and square stern. It had fourteen frames, a stern seat, one thwart about $2\frac{1}{2}$ to 3 feet forward of amidships, and a bow-platform about on a level with the thwart, this being $2\frac{1}{2}$ feet long. Aft there was a platform raised about 6 inches and extending $3\frac{1}{2}$ feet forward from the stern. There were three rowlocks, and a notch or scull-hole in the center of the stern to receive the steering-oar.

15. POUND-NET DINGHY.

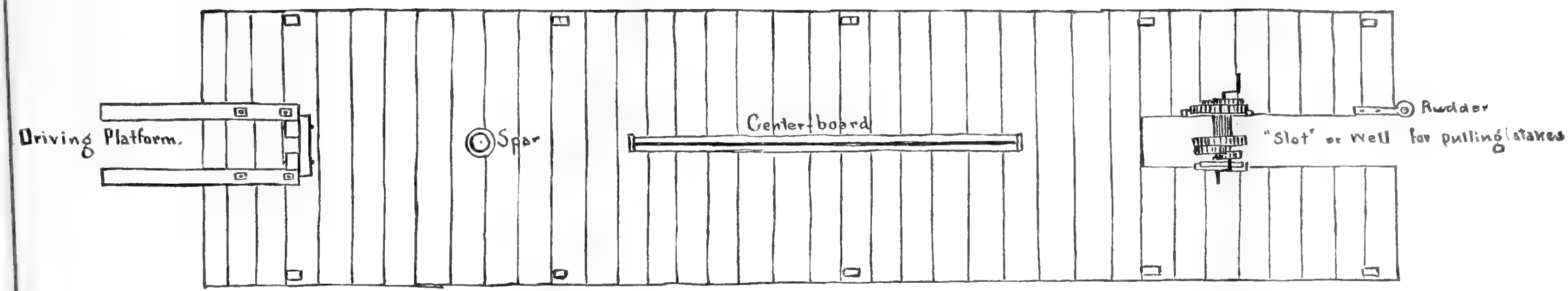
The so-called "pound-net dinkey," or dinghy, is of the sharpie pattern, though of a modified form, having a comparatively narrow flat bottom tapering at the ends, and a stern much narrower, in proportion, than that of the pound-boat. This boat is 16 to 18 feet in length and about 5 feet wide. It is used very generally by the pound fishermen of the lakes as a "tender," and is propelled wholly by oars.

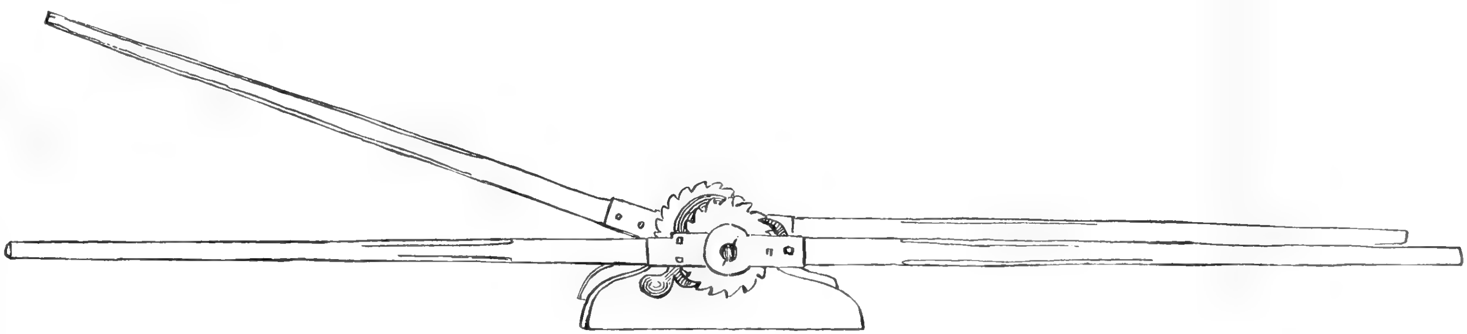


STAKE-BOAT AND CREW OFF MARBLEHEAD, LAKE ERIE, DRIVING STAKES FOR POUND-NET. (See page 29.)

(At close of the season the other end of the same boat pulls the stakes.)

Drawn by H. W. Elliott.





DECK PLAN OF STAKE-BOAT AND STAKE-PULLER OF LAKE ERIE. (See page 29.)

Drawn by H. W. Elliott

16. STAKE-BOAT OR PILE-DRIVER.

An important factor in the pound fisheries of the lakes is the stake-boat or pile-driver, which is used to drive the stakes for the pounds when the latter are being built, and is also employed to pull the stakes from the lake bottom at the close of the fishing season.

The stake-boat is a flat-bottomed scow, with straight vertical sides and raking square ends. It is decked, generally has a large center-board, and is provided at the bow with a frame-work for guiding the stake-driver, which is lifted by a tackle operated by hand. Two projecting pieces of plank form the driving platform, the stake being held between these until it is driven.

At the stern end of the scow there is usually a well extending some distance forward and having connected with it a sort of winch or crank windlass which is used for lifting the stakes.

When the stakes are to be driven the scow is secured by mooring lines so that she will lie steadily with a stake against her bow, between the two prongs of the driving platform and directly beneath the weight in the frame above. But when the stakes are lifted the boat is fastened so that she will be stern to them, and each in turn is brought into the "well," where the lifting purchase can be properly applied to it.

The rudder is hung to the stern on one side of the well. Along each side are several stanchions which serve the double purpose of holding on deck the stakes carried each day, and affording the means for fastening the mooring hawsers.

These boats vary in rig and size. Some of them are cat-rigged, carrying a single boom and gaff sail, like that shown in the illustration, Plate 9, while others have a schooner rig like the pound-boats. They range in length from 25 to upwards of 30 feet, and in width from 6 to 8 feet.

Strength and utility are the qualities chiefly sought in the construction of stake boats, which are generally built in a somewhat rough and cheap manner.


U. S. Commission of Fish and Fisheries.
M. McDonald, Commissioner
MAP SHOWING THE NUMBER AND LOCATION
OF THE
POUND NETS OPERATED IN
THE WATERS OF
LAKE SUPERIOR
DURING THE FISHING SEASON OF 1885.
DOMINION OF CANADA
MINNESOTA
LAKE SUPERIOR
WISCONSIN
MICHIGAN
POUND NETS IN ST. MARY'S RIV.
Michipicoten Id.
Slate Is.
Caribou Id.
THE APOSTLE ISLANDS
Outer Id.
Michigan Id.
Bayfield
Ashland
Ontonagon
Houghton
Portage Entry
Eagle River
Keweenaw Pt.
KEWEENAW BAY
L'Anse
MARQUETTE
Grand Marais
White Fish Pt.
WHITE FISH BAY

III.—THE FISHERIES OF LAKE SUPERIOR.

17. GENERAL REVIEW.

Introductory description.—Lake Superior empties its waters into the lower lakes by means of the St. Mary's River, a stream about 25 miles in length, navigable for lake craft of all sizes, except at its upper extremity, where the famous falls known as the Sault de Sainte Marie occur, this obstacle being overcome by means of a large ship-canal and a series of locks erected by the Government about thirty years ago. The lake, following the natural curvature through its middle, is about 420 miles long, and has a maximum breadth of 160 miles. Its depth varies from 80 to 200 fathoms.

The Canadian shores, extending from the St. Mary's River at the eastern extremity to Arrow River on the northwest, are very wild and contain only a scattered population of Indians and half-breeds, with no settlements of importance, the same being true of the Minnesota coast, stretching from that point to Duluth, 150 miles distant, at the extreme western end of the lake. The only communication along this northwest coast is by means of small steamers employed in collecting fish from the Duluth fishermen, who camp at different points along the shore during the summer months, and from the few Indians living in the region. The largest settlements are at Beaver Bay and Two Harbors, neither of which has a population of over fifty families, though at the latter point a railroad has been built, extending some distance into the interior, and a regular steam-boat connection has been established with Duluth.

The southern shores are somewhat irregular, with three peninsulas, those of Bayfield, Keweenaw, and Whitefish Point, which extend in a northeasterly direction.

Off the extremity of the first-named is a group of more than twenty bold, rocky islands, known as the Apostle Islands. The Keweenaw Peninsula is the largest and near its base is interrupted by a short canal connecting with natural lakes and rivers which allows the passage of lake craft without the delay and danger contingent upon rounding the peninsula. The third, at Whitefish Point, near the eastern end of the lake, is small and unimportant.

The coast is for the most part bold and rocky, covered with dense forests of pine and other native woods, which are broken at intervals by small turbulent streams rising some miles away in the heart of the

forest, and here and there by a river of considerable size, though, owing to the rocky character of the country, practically of no value for navigation. The principal rivers are the St. Louis, the Namadji, the White, the Montreal, the Presque Isle, the Ontonagon, and the Sturgeon. The character of the shore prevents any extensive population. There are frequent intervals of 50 miles or more where scarcely a clearing has been made or a building erected, the only inhabitants being the hunters, woodmen, Indians and half-breeds. At several points, however, notably Duluth, Chaquamegon Bay, the Keweenaw Peninsula, and Marquette, towns of considerable size have sprung up, these marking the lake termini of railroads, and having important business interests.

Duluth, for many years a mere village, has recently developed unusual activity, and in 1885 had a population of 18,000, with four different lines of railroad. This seems destined to be the largest city on the lake, and its favorable location at the extreme western end as well as its excellent railroad and harbor facilities, will probably enable it in the near future to control the trade of the adjacent States and Territories of the Northwest. For this reason its relation to the development of the fisheries at the western end of the lake is important and intimate.

Bayfield and Ashland, 65 miles east of Duluth, in the vicinity of the Apostle Islands, while places of only a few hundred inhabitants, are developing new energy, and, with the aid of the railroads, are endeavoring to build up large commercial interests. Ontonagon, the capital of a county of the same name, situated 75 miles farther east, has extensive lumber interests, though at present it is dependent wholly upon shipments by the lake steamers, and during the winter months, when navigation is closed, the business is necessarily interrupted. The Keweenaw Peninsula is thus far the only region having an extensive population. The rich iron and copper mines have for years offered inducements to settlers, and the entire peninsula is now dotted with mines worked to a greater or less extent. Farther east the only settlement of note is Marquette, a city of growing importance, which serves as an outlet for the rich iron mines lying a few miles to the southward.

General sketch of the fisheries.—Owing to the character of the coast the agricultural interests are now wholly undeveloped, and it is doubtful whether they will ever become important. Most of the business is confined to lumbering, mining, and fishing, and the products of these industries are conveyed to eastern markets by a fleet of several hundred steamers, barges, and sailing craft. The fisheries began in a small way with the earliest settlement of the country, but owing to the scattered population and the distance from the markets it was many years before they had grown to be of commercial importance. At first they were prosecuted wholly by the Indians and half-breeds of the region, to furnish food for themselves and their families, and it is only within the last fifteen years that extensive operations have been carried on by pro-

fessional fishermen. The first commercial fishing was at the eastern end of the lake in the vicinity of the Sault Ste. Marie and at Whitefish Point, where fishermen from the lower lakes located, shipping their catch to Detroit and Chicago by steam-boat; but with the building of railroads important fisheries have been developed at Duluth, Bayfield, and Marquette, and limited interests center at Houghton and L'Anse. There is also a small fishery near Grand Island, and at various times in the past fishing has been more or less extensive at Grand Marais and Ontonagon.

During the fall months many Bayfield and Duluth fishermen go to Isle Royale and remain there for some weeks to engage in the capture of whitefish and trout. Small collecting steamers visit the island regularly to carry away the fresh fish, any surplus being salted and sold to the dealers at Duluth and Bayfield.

Pound-net fishery.—Pound-nets were first used in the waters of Lake Superior in the year 1864, when several were set in Whitefish Bay by fishermen from Lake Michigan. The smaller pound-nets were set in the early spring at various points along St. Mary's River for the capture of pike and other species that were abundant in the locality, and later were brought to Whitefish Point and fished during the remainder of the season.

The fishery at Whitefish Point is still important, as two years later (1866) fishermen from Lake Erie came to the locality and began extensive fishing operations, which have been continued to the present time. A few years after the introduction of these nets at the eastern end of Lake Superior they were set in L'Anse Bay and at Marquette by fishermen coming from other lakes. In 1871 they were introduced into the fisheries of the Apostle Islands, which are now the principal center of the pound-net fishery, having about one hundred and twenty-five nets in the year 1885. They are also employed by the fishermen of Duluth, who set them at various points along the Wisconsin coast between Superior City and Iron River. Along the Minnesota shore of the lake they have never been used to any extent except at Washoogan Bay, near the Canadian line, where three or four are now to be found. Several have been fished along the shores of Isle Royale by fishermen from Bayfield and Houghton, the number being three in 1885.

Seine fishery.—Prior to the introduction of pound-nets seines were extensively used for catching the fish that chanced to be swimming in the vicinity of the shore; but these are now only occasionally employed for a few weeks, when the fishing is at its height, by those who are not so fortunate as to own pound-nets. The continued use of pounds is said to have interfered with the migrations of fish in the inshore waters, and seines are not now sufficiently remunerative to warrant their extended use.

Gill-net fishery.—Gill-nets have been employed in the whitefish and trout fisheries for many years, and in numerous localities they are still the most important form of apparatus used. All of the fishing

steamers proper, as distinguished from those collecting fish or "tending" pound-nets, are provided only with gill-nets. The larger steamers carry an enormous outfit, some of those at Duluth having more than 20 miles of netting, about one-fourth of which is kept constantly in the water. The mesh of the nets for whitefish and trout varies according to locality. That for trout in the fall and that for whitefish in the vicinity of Isle Royale is from 5½ to 6 inches, which is about an inch larger than the mesh employed for the capture of whitefish during the spring and summer months. Gill-nets are the only kind of apparatus suitable for use in the siscowet fishery, which is now extensively prosecuted in the deeper waters of the lake at a considerable distance from shore. A few nets of small mesh are employed for the capture of herring in the fall and early winter, both in open water and through the ice. Whitefish are also taken in considerable quantities with larger nets fished through the ice.

Gill-nets are in very general use by the fishermen of Duluth, who set them in various localities along the north shore and about Isle Royale. They are less extensively used than formerly at Bayfield, as pound-nets have come to be substituted to a large degree, though some of the men still employ them exclusively, and a majority of the other fishermen, after removing their pound-nets in August, operate gill-nets for the capture of trout and whitefish during the remainder of the season. The fishermen residing on Keweenaw Peninsula catch a majority of their fish with this form of apparatus, and at Marquette the steamer and sail-boat fishermen use them extensively. At Grand Marais they are the only nets employed, and at Whitefish Point large quantities of fish are taken in them.

Ice-fishing.—Winter ice-fishing has never been extensively carried on in the waters of Lake Superior, though the Indians have for many years used spears and decoys for catching fish when their supply of other food has become exhausted. Recently a limited winter fishery has sprung up at Duluth, and the fishermen of Bayfield are similarly engaged about the Apostle Islands and in Chaquamegon Bay for a few weeks. As already mentioned, gill-nets are occasionally fished through the ice for whitefish, but the principal methods of fishing at this season are with set-hooks and with spears. The former are attached to bent twigs, the free end having a line attached and bearing a flag, which serves as a signal to indicate that a fish has been hooked. A hundred or more of these are frequently set in a row through holes cut in the ice, while the fishermen occupy themselves in keeping the holes clear from ice and in removing the trout. The spears are used in connection with fish-lures or decoys, which are suspended in the water and kept in motion by means of a string, the fisherman standing just above the hole in the ice and spearing any trout that are attracted by the decoy.

Dip-net fishing.—Another form of fishing, one which is peculiar to this lake, is the dip-net fishing by the Indians in the rapids at

Sault Ste. Marie. This, at first sight, would seem to be a very primitive method, and one would naturally suppose that the catch would be unimportant, but an investigation shows that the Indians have become very expert in the use of these nets, and succeed in landing many tons of fish during the season. Two of them fish together from a small canoe, one remaining in the bow with the dip-net watching for fish, which are seen at a considerable depth below the surface of the water, while the other sits in the stern and paddles the canoe about in the rapid current.

Fishermen.—The fishermen of this lake are mostly French Canadians, with more or less Indian blood, and full blooded Indians, together with a small number of Swedes and Norwegians. Very few Americans are employed, though the dealers are usually of the last-named nationality. At Duluth and Bayfield the apparatus is supplied in large part by the dealers, who take fish in payment. The dealers usually furnish the apparatus to a reliable and energetic fisherman, who in turn makes an agreement with one or two men to assist him, either for definite wages or a share in the catch. Dealers thus look to the captain of the gang for the settlement, and, though they claim to sell the apparatus outright, it frequently happens that when the catch is small they are obliged to keep control of the gear from season to season and maintain an open account with the fishermen. At Whitefish Bay the entire plant, including nets, buildings, steamers, and all other apparatus, is owned by a fisherman, who gives his personal attention to superintending and hires men for the work. At other points along the lake most of the apparatus is owned by the fishermen themselves, who either sell their catch to dealers or ship by steamer or rail to the larger cities.

Species taken.—The principal species taken are whitefish, trout, and siscowet. Herring seem to be abundant, but few are taken at any season, except during a few weeks in the fall and occasionally in the early spring. Pike are not taken in any quantities. Suckers are considered worthless, and sturgeon, though often captured, are seldom marketed.

Season.—The fishing season is shorter than that of any of the other lakes, owing to the severe climate. It seldom begins before May, and by October most of the apparatus, except that employed in the ice-fishing, mentioned above, is laid aside. At Duluth there is a tendency to continue the fisheries by means of tugs and sail-boats well into the winter, and at Bayfield pound-nets have been set under the ice, but so far no important fishery has been developed during the winter months.

Trade.—Two Duluth dealers control the entire catch of that locality, and send their collecting steamers to all points along the north shore as far as Isle Royale, a distance of nearly 200 miles, and along the south shore between Duluth and the Apostle Islands. They ship the fish chiefly to St. Paul and Minneapolis, from which centers they are distributed to the interior. The steamers make frequent trips, and a majority of the fish are marketed fresh, the fishermen salting their catch only when

the boats are delayed in reaching them, or at times when there is an over-supply in the market. The catch of the Apostle Islands is controlled largely by three dealers at Bayfield, two employing steamers and sail-boats for collecting fresh fish, and the other handling salt fish exclusively. Nearly all of those landed fresh are sent to Minneapolis and St. Paul for distribution. The salt fish are chiefly consigned to Chicago, Detroit, Cleveland, and Buffalo. Nearly the entire catch between Ontonagon and Huron Bay is salted, as there are there no fresh-fish dealers, and little opportunity for handling fresh fish. The same is true of Grand Island and vicinity. Good railroad facilities at Marquette enable the fishermen to ship the bulk of their fish fresh.

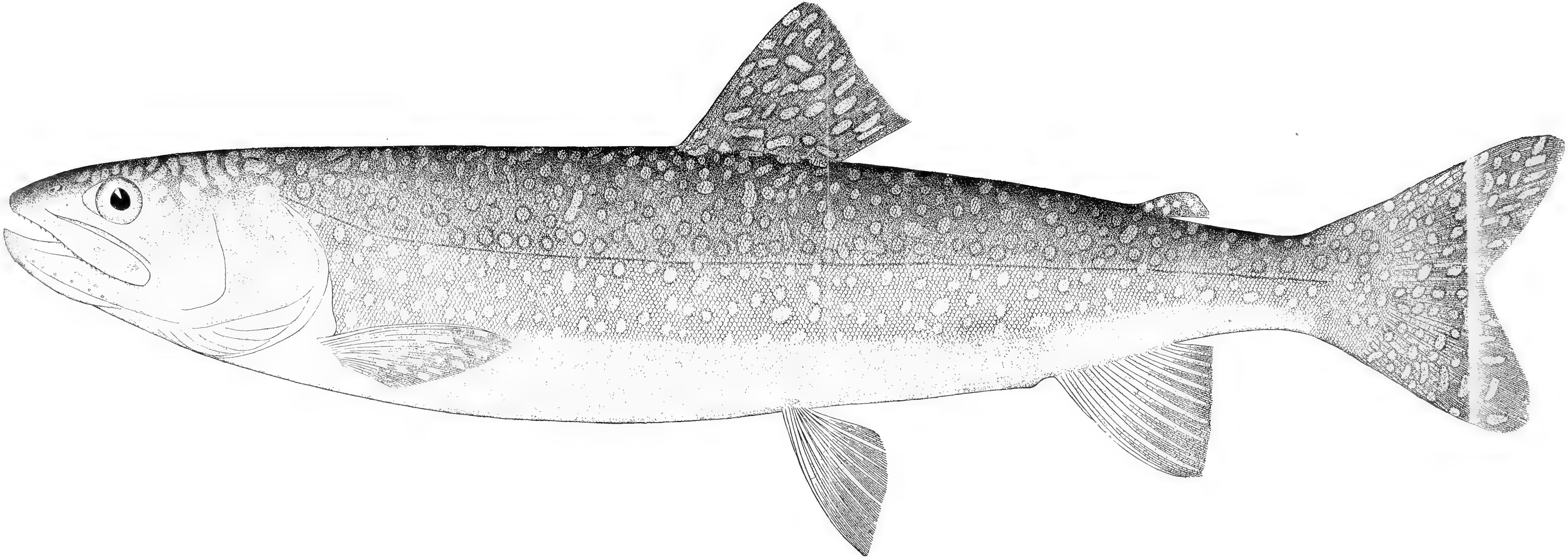
Whitefish Point being located almost in the path of the lake steamers, arrangements have been made by which those bound for Chicago touch there regularly, thus enabling the fishermen to dispose of most of their fish fresh. The fish taken by the Indians near the mouth of the St. Mary's River and those caught along the Canada shores to the northward are landed at Sault Ste. Marie and iced for shipment to the principal cities of Ohio, Michigan, and Illinois.

If we except the few fish smoked by the Indians for their own use and the limited quantity similarly prepared by a dealer, who began business at Duluth in 1885, there has been no smoking of fish along the shores of Lake Superior. An explanation of this is found in the fact that fish of large size are abundant, and the apparatus employed in most localities is not adapted to catching small fish, which, owing to the demand for large ones at a good price, are the only ones that could be smoked with profit.

Propagation—Shortly after the close of the investigation of 1885, the results of which are embodied in this report, the leading fishermen of the lake organized themselves into an association for the promotion of wise fishery legislation and of the artificial propagation of the principal food-fish of their waters. Their appreciation of the past work of the United States and State commissions in maintaining the fish supply of the country, was shown by the following petition presented by citizens of Duluth in the spring of 1886, asking for the inauguration of extensive fish-cultural work in Lake Superior. This document, which seems worthy of presentation in full, reads as follows:

The fishermen of Lake Superior, whose market and shipping point is at Duluth, Minnesota, feel the need of some relief being obtained for them from the U. S. Fish Commission, and ask a careful consideration of the facts as presented to Prof. Spencer F. Baird, the Commissioner, and do hereby petition you to use your influence in securing for them the favors herein set forth.

They have formed themselves into an association to promote their mutual interests, their aims and objects being to bring about a better understanding of the fishing laws of States; a uniform action amongst the fishermen concerning the regulation of the sizes of the meshes of all kinds of nets, and the enforcement of the laws concerning them; and also to secure the artificial propagation of the spawn of both whitefish and lake trout by a fish hatchery.



LAKE TROUT (*Salvelinus namaycush*).

Natural size of artificially propagated specimen raised at Northville, Michigan; 3 years and 3 months old; weight, 1 pound 5¼ ounces.

To this end we have pledged ourselves to aid by manual labor, and by the use of our fishing plants and men, in procuring spawn in the season for such a fish hatchery.

Realizing that the capital invested in the fishing industry is not proving remunerative under existing circumstances, and realizing from our past experience of the continually diminished catches both of whitefish and lake trout that the fish are decreasing by one-third of the previous year's catch year by year, we therefore feel the necessity of providing for larger deposits of the fry of these fishes, and assure you that a better sentiment is prevailing to-day amongst fishermen concerning the production of such fry.

While gratefully acknowledging the good work done by the Minnesota Fish Commission for us as fishermen, and the kindly interest evinced by Hon. Spencer F. Baird in the wellfare of the fishermen of Lake Superior, yet we pray you to introduce a bill asking for an appropriation to establish a fish hatchery under the instruction and charge of the U. S. Fish Commission; and we have assured Professor Baird that we will aid by such manual labor as may seem fitting to the U. S. Fish Commission or the assistants and place our apparatus and fishing plants at their disposal in collecting and procuring spawn for this hatchery, and to this end your petitioners will ever pray, etc.

R. H. PALMER,
President.
MARTYN WHEELER,
RASMUS S. JOHNSON,
NILS HARRISON,
Vice-Presidents.
W. DAVID TOMLIN,
General Secretary.
E. S. SMITH,
Treasurer.
EBENEZER FALCERNER,
WILLIAM OSBORN,
And one hundred and fifty-six others.

In accordance with this petition a hatchery has since been established at Duluth by the U. S. Fish Commission and placed in charge of Dr. R. O. Sweeny, an experienced fish-culturist, formerly state fish commissioner of Minnesota. It is one of the largest and best appointed establishments of its kind in the United States.

Statistics.—The following tables show the extent and production of the fisheries of Lake Superior during the year 1885:

Table of persons employed in the fisheries of Lake Superior in 1885.

Town or section.	Fishermen. Professional.	Fishermen. Semi-professional.	Shoresmen.	Preparators.	Total.	Persons dependent on the foregoing.
Minnesota shore north of Duluth	5	25	....	....	30	89
Duluth, Minnesota, and vicinity	125	32	6	32	195	308
Bayfield, Wisconsin	167	15	....	33	215	400
Ashland, Wisconsin, and vicinity	21	....	....	2	23	60
Ontonagon, Michigan, and vicinity	10	....	....	....	10	15
Keweenaw Peninsula, Michigan	108	20	....	2	130	248
L'Anse and Baraga, Michigan	22	40	....	20	82	100
Huron Bay, Michigan	7	....	....	1	8	32
Marquette, Michigan	14	8	5	2	29	63
Au Train, Michigan	10	6	....	....	16	40
Munising and Grand Island, Michigan	18	3	....	....	21	46
Grand Marais, Michigan, and vicinity	6	12	....	....	18	15
Whitefish Point, Michigan	16	....	3	4	23	52
Sault de Ste. Marie, Michigan, and vicinity	93	8	3	10	114	220
Total	622	169	17	106	914	1,688

Table of apparatus and capital employed in the fisheries of Lake Superior in 1885.

Town or section.	Vessels and boats.									
	Steamers.				Sail-boats.					
	Fishing steamers.		Collecting steamers.		Gill-net boats.		Pound-net boats.		Sail-boats collecting fish.	
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Minnesota shore north of Duluth					18	$1,200	2	$80		
Duluth, Minnesota, and vicinity	3	$9,500	2	$13,000	37	4,625	5	150		
Bayfield, Wisconsin	1	11,000	1	5,500	40	4,000	45	1,575	2	$3,500
Ashland, Wisconsin, and vicinity					3	100	5	35	2	500
Ontonagon, Michigan, and vicinity					3	300	1	40		
Keweenaw Peninsula, Michigan	2	1,800	1	2,000	51	5,865	7	280		
L'Anse and Baraga, Michigan					4	100	7	175		
Huron Bay, Michigan					2	250	2	80		
Marquette, Michigan	2	6,500			2	245	2	65		
Au Train, Michigan					1	90	1	25		
Munising and Grand Island, Michigan					1	25	3	300		
Grand Marais, Michigan, and vicinity					2	300				
Whitefish Point, Michigan	1	8,300					4	160		
Sault de Ste. Marie, Michigan, and vicinity	1	2,500	1	8,000	25	4,375	10	420		
Total	10	39,600	5	28,500	189	21,475	94	3,385	4	4,000

Town or section.	Vessels and boats—Continued.					
	Row-boats.				Total.	
	Seine-boats.		Scows and small boats.			
	No.	*Value.*	*No.*	*Value.*	*No.*	*Value.*
Minnesota shore north of Duluth			15	$200	35	$1,480
Duluth, Minnesota, and vicinity	5	$125	28	310	80	27,710
Bayfield, Wisconsin	15	450	105	1,500	209	27,525
Ashland, Wisconsin, and vicinity			4	40	14	675
Ontonagon, Michigan, and vicinity	3	90			7	430
Keweenaw Peninsula, Michigan			4	90	65	10,035
L'Anse and Baraga, Michigan					11	275
Huron Bay, Michigan			1	10	5	340
Marquette, Michigan	3	65	4	55	13	6,930
Au Train, Michigan					2	115
Munising and Grand Island, Michigan					4	325
Grand Marais, Michigan, and vicinity	2	75	3	55	7	430
Whitefish Point, Michigan	1	25	3	90	9	8,575
Sault de Ste. Marie, Michigan, and vicinity			21	595	58	15,890
Total	29	830	188	2,945	519	100,735

Town or section.	Apparatus of capture.							
	Gill-nets.			Pound-nets.		Haul-seines.		
	No.	Length.	Value.	No.	Value.	No.	Length.	Value.
		Feet.					*Feet.*	
Minnesota shore north of Duluth	300	72,000	$1,500	4	$1,400	5	2,475	$400
Duluth, Minnesota, and vicinity	780	1,129,128	22,330	20	7,500	8	5,280	360
Bayfield, Wisconsin	2,000	780,000	11,000	124	37,200	8	4,950	480
Ashland, Wisconsin, and vicinity	150	58,500	825	20	6,000			
Ontonagon, Michigan, and vicinity	150	58,500	825	1	250	3	1,980	225
Keweenaw Peninsula, Michigan	2,370	1,057,128	23,550	10	2,700	10	3,300	600
L'Anse and Baraga, Michigan	38	14,580	400	7	2,070			
Huron Bay, Michigan	90	32,400	900	2	600			
Marquette, Michigan	315	249,300	4,140	5	1,125	3	1,072	405
Au Train, Michigan	14	21,000	168	1	250			
Munising and Grand Island, Michigan	20	9,900	224	5	1,500			
Grand Marais, Michigan, and vicinity	60	25,200	480			5	3,300	375
Whitefish Point, Michigan	60	108,000	2,160	7	2,075	1	660	75
Sault de Ste. Marie, Michigan, and vicinity	1,210	665,010	9,580	24	4,850			
Total	7,557	4,280,646	78,082	230	67,520	43	23,017	2,920

Table of apparatus and capital employed in the fisheries of Lake Superior in 1885—Cont'd.

Town or section.	Apparatus of capture—Continued.				
	Set-lines.			Value of fykes, dip-nets, spears, and hand-lines.	Total value of apparatus of capture.
	No.	Length.	Value.		
		Feet.			
Minnesota shore north of Duluth	25	22,000	$50	$25	$3,378
Duluth, Minnesota, and vicinity	30	136,000	120		30,310
Bayfield, Wisconsin				65	48,745
Ashland, Wisconsin, and vicinity					6,825
Ontonagon, Michigan, and vicinity					1,300
Keweenaw Peninsula, Michigan	8	36,000	48	500	27,398
L'Anse and Baraga, Michigan				90	2,560
Huron Bay, Michigan					1,500
Marquette, Michigan					5,670
Au Train, Michigan	4	18,000	28	69	515
Munising and Grand Island, Michigan				83	1,807
Grand Marais, Michigan, and vicinity					855
Whitefish Point, Michigan				20	4,330
Sault de Ste. Marie, Michigan, and vicinity				54	14,484
Total	67	212,000	246	909	149,677

Town or section.	Shore property.					Total capital invested.
	Value of wharves and buildings.	Fish-cars.		Value of other apparatus and accessories.	Working capital.	
		No.	Value.			
Minnesota shore north of Duluth	$300			$100	$100	$5,358
Duluth, Minnesota, and vicinity	23,225			4,675	15,400	101,320
Bayfield, Wisconsin	19,250	25	$150	7,860	26,000	129,530
Ashland, Wisconsin, and vicinity	1,500			600	600	10,200
Ontonagon, Michigan, and vicinity	500			200	150	2,580
Keweenaw Peninsula, Michigan	9,500			7,850	2,800	57,583
L'Anse and Baraga, Michigan	500			607		3,942
Huron Bay, Michigan	400			125	100	2,465
Marquette, Michigan	10,400			3,890	4,025	30,915
Au Train, Michigan				10		640
Munising and Grand Island, Michigan	400			154		2,686
Grand Marais, Michigan, and vicinity	500			200	100	2,085
Whitefish Point, Michigan	8,350			2,100	2,100	25,455
Sault de Ste. Marie, Michigan, and vicinity	12,500	100	3,000	2,800	4,500	53,174
Total	87,325	125	3,150	31,171	55,875	427,933

Table of products of the fisheries of Lake Superior in 1885.

Town or section.	Fresh.							
	White-fish.	Trout.	Sisco-wet.	Stur-geon.	Herring.	Pike.	Other fish.	Total.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
Minnesota shore north of Duluth	38,000	28,000	10,000	....	....	2,000	....	78,000
Duluth, Minnesota, and vicinity	400,000	500,000	270,000	10,000	25,000	110,000	....	*a*1,315,000
Bayfield, Wisconsin	310,000	200,000	60,000	15,000	40,000	15,000	....	640,000
Ashland, Wisconsin, and vicinity	100,000	125,000	40,000	*b*27,000	*c*20,000	....	....	312,000
Ontonagon, Michigan, and vicinity	25,000	16,000	2,500	....	1,500	1,000	....	46,000
Keweenaw Peninsula, Michigan	116,000	136,000	40,000	....	140,000	5,000	7,000	444,000
L'Anse and Baraga, Michigan	59,914	54,720	....	4,760	14,280	1,904	*d*16,122	151,700
Huron Bay, Michigan	8,000	5,000	....	....	....	....	2,000	15,000
Marquette, Michigan	96,900	75,380	140,700	....	20,450	....	5,000	338,430
Au Train, Michigan	5,063	16,627	....	....	....	....	610	22,300
Munising and Grand Island, Michigan	37,870	18,050	....	....	....	....	6,080	*e*62,000
Grand Marais, Michigan, and vicinity	12,000	10,000	1,800	1,500	3,000	....	2,000	30,300
Whitefish Point, Michigan	300,000	148,000	....	2,500	1,500	2,000	1,000	455,000
Sault de Ste. Marie, Michigan, and vicinity	597,000	193,000	35,000	122,000	8,000	35,000	10,000	1,000,000
Total	2,105,747	1,525,777	600,000	182,760	273,730	171,904	49,812	4,909,730

Town or section.	Salted.							Total.	
	White-fish.	Trout.	Sisco-wet.	Her-ring.	Pike.	Other fish.	Total.	Pounds.	Value to fishermen.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*		
Minnesota shore north of Duluth	40,000	18,000	....	....	....	......	58,000	136,000	$3,970
Duluth, Minnesota, and vicinity	150,000	400,000	150,000	10,000	13,000	......	723,000	2,038,000	75,680
Bayfield, Wisconsin	1,820,800	305,700	51,000	10,000	5,000	......	2,192,500	2,832,500	60,080
Ashland, Wisconsin, and vicinity	12,000	2,000	1,000	....	....	......	15,000	327,000	11,350
Ontonagon, Michigan, and vicinity	29,000	15,000	3,000	2,500	....	......	49,500	95,500	4,245
Keweenaw Peninsula, Michigan	158,300	197,300	50,000	15,000	....	......	420,600	864,600	34,170
L'Anse and Baraga, Michigan	28,000	1,750	....	5,250	....	......	35,000	186,700	7,496
Huron Bay, Michigan	28,000	15,000	....	....	....	......	43,000	58,000	2,460
Marquette, Michigan	4,500	20,940	23,110	700	....	......	49,250	387,680	13,250
Au Train, Michigan	3,500	300	....	....	....	......	3,800	26,100	1,777
Munising and Grand Island, Michigan	32,600	3,600	....	....	....	......	36,200	98,200	3,770
Grand Marais, Michigan, and vicinity	10,000	8,000	700	5,000	....	3,000	26,700	57,000	2,080
Whitefish Point, Michigan	89,500	26,000	....	2,500	1,500	2,000	121,500	576,500	23,500
Sault de Ste. Marie, Michigan, and vicinity	60,000	60,000	10,000	....	10,000	2,200	142,200	1,142,200	48,110
Total	2,466,200	1,073,590	288,810	50,950	29,500	7,200	3,916,250	8,825,980	*f*291,938

a Including over 20,000 pounds of whitefish, trout, sturgeon, and herring sent to smoke-house.
b Including 15,000 pounds smoked.
c Including 5,000 pounds smoked.
d Including 2,856 pounds of brook trout, sold at 25 cents per pound.
e Including several hundred pounds smoked.
f Including $415, the value of 1,000 gallons of oil, 200 pounds of caviare, and 600 sounds for making isinglass.

18. MINNESOTA SHORE NORTHEAST OF DULUTH, AND ISLE ROYALE (COOK AND PART OF ST. LOUIS COUNTIES).

Fishing centers.—The only places along the main shore, stretching about a hundred and fifty miles northeast of Duluth, from which fishing is carried on are Horseshoe Bay and Grand Marais.

Horseshoe Bay.—This is a good harbor, where fishermen from Duluth occasionally locate and build rude shanties during the fishing season. There is no settlement, and the fish are taken away by the Duluth steamers that run in solely for the purpose of purchasing the catch and supplying the fishermen with provisions.

Grand Marais.—Grand Marais, the county seat of Cook County, is a small lake village containing three or four families of whites, and from twelve to fifteen families of half-breeds and Indians. There is one store, the proprietor of which trades with the Indians and provides them with small nets, in which they catch fish for their own use, and occasionally a few pounds for sale. He also buys the catch of one or two gill-net crews from Duluth that remain here for a few months to fish, and sells them to the Duluth steamers that come regularly to purchase. In 1884 he handled 25 tons of fish, but in 1885 the business was greatly reduced, the total for the year not exceeding 5 tons, all of which went to Duluth, and are included in the statistics of that city.

Description and history of Isle Royale.—This island is 50 miles long by 15 to 20 miles wide. It is situated 150 miles northeast of Duluth and 40 miles northwest of Keweenaw Point. Eight or ten years ago it had extensive mining interests, and a village named Minong contained fifteen to twenty families in addition to the miners. Since that time the mining has been wholly discontinued and one after another the miners have moved from the island, the last one leaving in the fall of 1883. The island is quite rocky, and in some places is heavily wooded with small trees. Its waters abound in fish of unusual size, whitefish of 15 to 18 pounds weight being, according to Mr. La Vaque, of Duluth, not uncommon, while those of even larger size are occasionally caught. The trout also are very large, averaging 15 or 20 pounds in weight.

History of Isle Royale fisheries.—The numerous excellent harbors make it a favorite resort for fishermen, and for quite a number of years those from Houghton, Bayfield, and Duluth have fished along its shores. They usually provide themselves with gill-nets and camp on the Island during the fishing season. Formerly they salted their catch and brought it back with them at the close of the season. In 1883 there were no less than sixty crews, forty of which were from Bayfield alone, and in 1884 there were about two-thirds as many, but as the fishing was poor in that year there were very few in 1885. For ten years pound-nets owned by fishermen of the south shore have been set in these waters, and as early as 1878 three from Houghton were fished with excellent success. In 1883 three pound-nets were set there by Duluth fishermen.

Present condition of Isle Royale fisheries.—In the year 1885 there were two pound-nets, one fished by Houghton and the other by Duluth fishermen. There were in addition one steamer and eleven crews of gill-net fishermen from Duluth and an equal number from Houghton and other places. About the year 1883 steamers from Duluth began visiting the Island at regular intervals for the purpose of buying the fish and supplying the fishermen with provisions and such additional apparatus as they might require. The business has continued to develop, until now a large percentage of the catch is sold fresh. The fishing season is usually from the middle or last of August until well into November, when the weather becomes too stormy to admit of regular work, and the fishermen return to their homes and either discontinue the work for the winter or fish from the vicinity of their own towns. The statistics of the catch at Isle Royale is included in the figures for the places where the fishermen reside.

In the fall of 1883 the yield at Isle Royale was unusually large, and in 1884 not less than thirty boats were there, but, owing to a heavy storm early in the season, which drove the fish away, the catch was so light that they hardly paid expenses, and in 1885 there were not more than twenty boats. The fishing is principally from Rock Harbor, near the eastern extremity of the island, Siscowet Bay on the south side, and Washington Harbor on the western end, there being very little from the north shore.

Statistical recapitulation.—The number of persons employed in 1885 in the fisheries of that part of Minnesota bordering the northern side of Lake Superior was thirty. These used eighteen gill-net boats, two pound-boats, and fifteen other boats. The apparatus of capture consisted of three hundred gill-nets, four pound-nets, five haul-seines, twenty-five set-lines, and a number of spears. The total value of apparatus of capture was $3,378, of shanties $300, and of cash capital and accessories $200. The products consisted of 38,000 pounds of fresh whitefish, 40,000 pounds salt whitefish, 28,000 pounds fresh trout, 18,000 pounds salt trout, 10,000 pounds siscowet, and 2,000 pounds pike, the whole having a value of $3,970.

19. DULUTH, ST. LOUIS COUNTY, MINNESOTA, AND VICINITY, AND DOUGLAS COUNTY, WISCONSIN.

Development of the city.—Duluth, situated at the extreme western end of Lake Superior, at the mouth of St. Louis River, is to-day one of the most important shipping points on the lake. A settlement was made there many years ago, but for a long time the growth of the village was very slow, owing to the lack of railroad communication with the interior, and in 1880 the town contained less than 4,000 people. The building of railroads gave it a new impetus, and during the next five years it developed with remarkable rapidity, the percentage of increase being perhaps greater than that of any other city in the United States. The

population had increased to 13,000 in 1883, and in 1885 numbered about 18,000, and the greatest activity was everywhere manifest. Four or five railroads communicate with the interior, and this port seems destined to command the water shipments from a large portion of the Northwest. There are already eight or ten grain elevators, and work has also been commenced on a series of docks, which will give abundant wharf room for a large fleet of vessels. The harbor is large and well protected. There are extensive saw-mills, and quite a trade in supplying merchandise to the smaller inland settlements has already sprung up.

History of fishing interests.—The fisheries have developed in an equal ratio with the other industries. Comparatively few years ago they were carried on only by a few boats that fished with great irregularity, the fishermen disposing of a portion of their catch in the village and shipping the remainder to St. Paul and Minneapolis. The business was at this time retarded by the smallness of the demand, and, as no regular trade had developed, the fishermen could not carry on the work with any steadiness. In the spring of 1880 the entire trade was controlled by one firm, who had for two years prior to this time been running a small steamer, the *Fred and Will*, along the shores for a number of miles to purchase the fish from the fishermen who camp there during the fishing season. About that time another firm began handling fish, and in 1884 a third party, owning a small fishing steamer, shipped his own catch in addition to limited quantities of fresh fish which he bought directly from the pound-net and gill-net fishermen.

Present condition of the fisheries.—During the season of 1885 the trade in both fresh and salt fish was controlled by two firms, Cooley, La Vaque & Co., and the Duluth Fish Company, each having one steamer, which they sent to all fishing camps along both the south and north shores of the lake, from the Apostle Islands to Isle Royale, and to one or two little Canadian harbors, a distance of two hundred miles from Duluth. There were during the year mentioned about forty crews, of two or three men each, fishing with gill-nets for whitefish and trout; and three steamers, with five men each, engaged in the same fishery. There were in addition 14 pound-nets owned by Duluth fishermen, and six more by those from Superior, fished along the south shore. A large part of the catch is sold fresh, but when there is a surplus, or when for any reason the collecting steamers do not arrive, the fish are salted and sold in that condition. In 1885 the catch by Duluth fishermen and by the seines and pound-nets at Superior amounted to 2,058,000 pounds, valued at $75,680. Of this amount 400,000 pounds of whitefish, 500,000 pounds of trout, 270,000 pounds of siscowet, 10,000 pounds of sturgeon, 25,000 pounds of herring, and 110,000 pounds of pike, were sold fresh, and 1,500 half-barrels of whitefish, an equal quantity of siscowet, 4,000 half-barrels of trout, 100 half-barrels of herring, and 130 half-barrels of pike were salted.

Fishermen.—The fishermen are mostly natives of Norway, with a few French Canadians and Americans, and two or three Germans. About

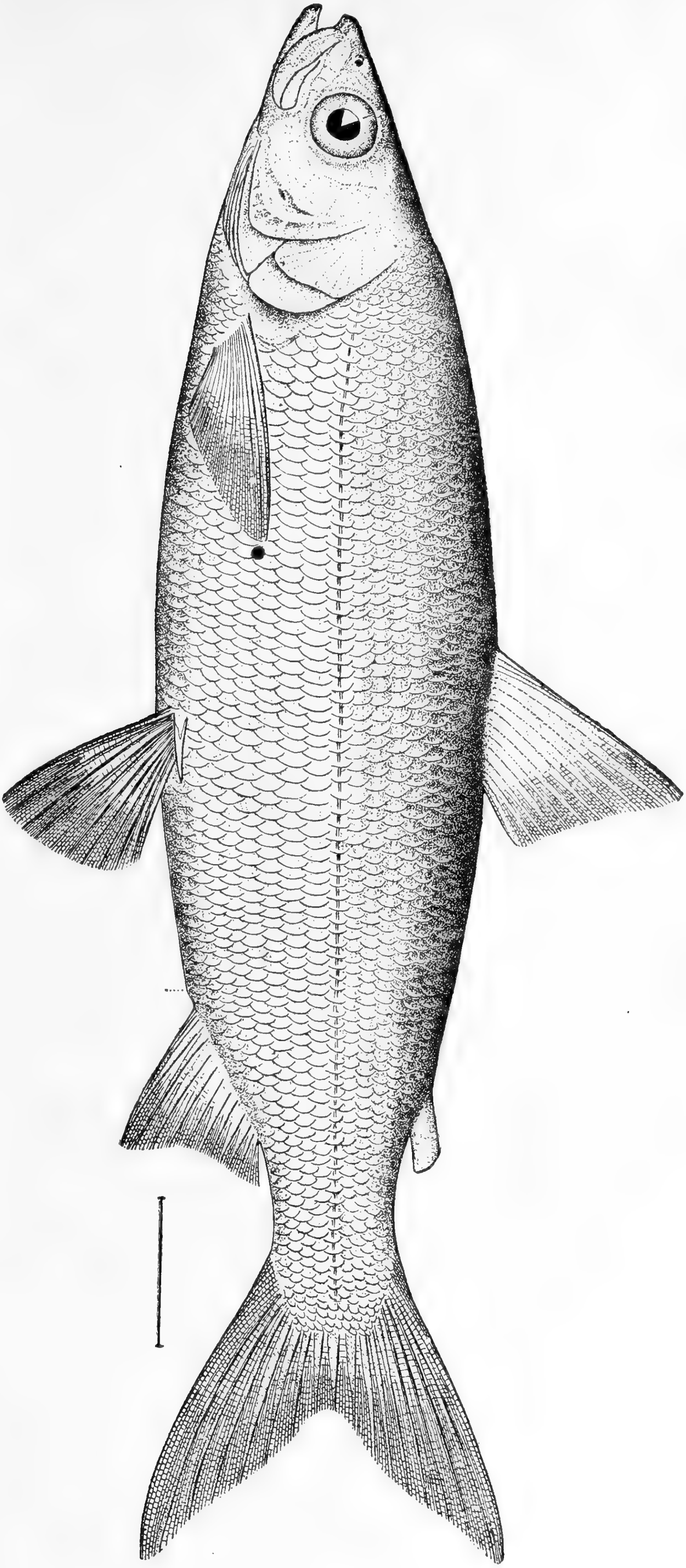
half of the entire number are married, and nearly all control their own apparatus in preference to fishing on shares.

Prices and trade.—The prices paid to the fishermen vary somewhat with the season. In spring and fall that of fresh fish reaches 5 and even 6 cents per pound, but in the summer it falls to $2\frac{1}{2}$ or 3 cents, the average at the time of our visit being $2\frac{1}{2}$ cents for trout and whitefish. The dealers furnish salt and barrels, and pay the fishermen $1.75 for filling with trout and siscowet, $1.25 for pike, and $3 for whitefish. Of the fresh fish landed at Duluth about 40 per cent. go to Minnesota, three-quarters of these being sent directly to St. Paul and Minneapolis. Twenty-five per cent. go to Iowa, 15 per cent. to Wisconsin, an equal quantity to Dakota, and the remainder to Kansas City. Of the salt fish fully three-quarters go to St. Paul and Minneapolis, the remainder going chiefly to Chicago.

Gill-net fishery.—Gill-nets have been extensively used for many years in the capture of whitefish and trout, and the gill-net fishery is at present of much greater extent than any other. In 1880 there were about a dozen boats fishing from the village. Formerly the gill-netters fished in the immediate vicinity of Duluth, running their catch there to be sold fresh or salted, but with the introduction of steam collecting boats they were enabled to go further from home, and in 1884 sometimes fished a hundred miles distant, the steamer going as far as Grand Marais. At present during the fall they fish anywhere within 200 miles of Duluth, the steamers running to Isle Royale and along the main shore beyond the Minnesota boundary. The fishing begins early in April, as soon as the ice breaks up, and, after working for several weeks in the immediate vicinity, the men move to the south shore and remain there until the middle of July. At that time the catch is light and about half of them "cut out" for three to six weeks to repair their nets, while the others proceed to the small harbors and creeks along the north shore, where they are joined about the last of August by their colaborers. They continue here till about the middle of November, when they return to Duluth and fish for two or three weeks from the harbor, after which their boats are hauled up for the winter and the fishing practically ceases, though a few of the men set nets through the ice as soon as it is strong enough for them to venture upon it.

When fishing at a distance they build rude shanties, where they find shelter from the storms, and dress and salt their catch. They depend wholly upon the collecting steamers, both for the transportation of their fish and for their supplies. The dealers aim to secure as many fish fresh as possible, and for this reason make frequent visits to the fishing stations, stopping both in running up and down the shore. They also furnish the fishermen with salt and barrels, paying them a stated price for filling them. A majority of the boats carry only two men; perhaps about one-fourth of the entire number

PLATE XIII.



LAKE HERRING OR CISCO (*Coregonus artedi*).

have three, and others will occasionally employ an extra man during the height of the fishing season.

Some fishermen have nets of fine twine, with a 4½- to 5-inch mesh, for spring fishing, when the whitefish are most abundant, and others of 5¼ to 5½, or even 6 inches, of heavier twine, for fall fishing, when the trout predominate; but a majority have medium-weight nets of 5- to 5½-inch mesh, which they use throughout the entire year. The nets are about 250 fathoms or 1,500 feet long, and from fifteen to seventeen meshes deep, costing when new about $30 each. They are set in gangs of five to eight nets each, each boat being provided with about four gangs, three of which are kept in the water and one on the shore to dry. One gang is hauled and set daily when the weather will permit, and in cases where fish are very abundant two gangs are occasionally hauled.

The catch, according to Mr. George N. La Vaque, who has furnished much information for this report, varies from 10,000 to 40,000 pounds of fish per boat, averaging in 1884 about 30,000 pounds. Of these about 10 per cent. are whitefish, and 5 per cent. wall-eyed pike, the remaining 85 per cent. being lake trout and siscowet, in the proportion of about 9 pounds of the former to 5 of the latter. The whitefish weigh, according to the same authority, from 2½ to 5 pounds each, round, the trout from 5 to 6 pounds, and the siscowet from 4½ to 5 pounds. Of the entire gill-net catch from sail-boats, about one-half of the whitefish and one-third of the trout and siscowet are salted, the remainder, together with nearly all of the pike, being sold fresh. Up to 1883 gill-net fishing was wholly with sail-boats. At that time a small fishing-steamer was employed, and two years later there were three fishing steamers, the *Amethyst*, the *J. W. Eviston*, and the *Henry F. Brower*, carrying five men each, and using an average of fifty to seventy nets to the boat. The average catch of two of the steamers in 1884 amounted to 120,000 pounds, the other steamer, which is employed a greater part of the year in marketing the catch of the pound-nets, taking only about 20,000 pounds. None of these fish, according to Capt. E. S. Smith, are salted, the steamers usually running their catch direct to market.

Gill-net fishing through the ice has not yet become extensive in the vicinity of Duluth. The first to engage in this kind of fishing was Captain Smith, who began in February, 1884, and was soon joined by two other crews. The next year there were five crews fishing ten or twelve nets each. The fishing begins shortly after the 1st of January and continues till the ice softens and is considered unsafe for the men to venture upon it. The catch, which is made up largely of trout, varies considerably, averaging perhaps 20,000 to 25,000 pounds of fish for each crew.

Pound-net fishery.—No definite record can be obtained of the beginning of pound-net fishing about Duluth; but, about 1873, pounds were fished along the north shore of the lake, near the boundary between

Minnesota and Canada, and they have been employed to a limited extent in different localities since that time. In 1884 there were ten nets owned by Duluth fishermen, and two additional ones owned in Superior. The next year there were twenty nets, six of which were owned at Superior and the remainder at Duluth. A majority of them were set along the outer shore, just east of Superior; but a few, fished by a man residing at Iron River, were located as far west as that point. The nets were set in water from 20 to 50 feet in depth, having leaders 60 yards long and pots 20 to 30 feet square, the cost, complete, varying from $250 to $450. They are put in the water by the middle of May, and fished until the 1st of August, when they are usually taken out, though a few are reset in October and fished for five or six weeks. The catch in 1884 was the largest ever known, one man, who operated seven pounds, stocking $9,000, although one-third of his catch was salted. In 1885 the same person, with nine nets, stocked only $1,200, the yield of all the nets being unusually light. A small steamer is employed exclusively in transporting the catch for pound-nets during the season, but fishes with gill-nets at other times.

Seining.—Seine-fishing has been followed on a small scale along the north shore and about Duluth and Superior from the earliest settlement of the country, short seines being usually employed. A large one was operated, with excellent success, on the north side of Pigeon Point, near the Canadian line, as early as 1873, and for a number of years subsequently large quantities of whitefish were caught for salting. Between 1875 and 1880 there was a considerable amount of seining at Fond du Lac, about 10 miles above Duluth, on the St. Louis River, the catch being chiefly pike, with a few whitefish and herring, but of late the business has been of little importance. The principal seining grounds about Duluth are along the sandy beaches in the vicinity of Superior, and in 1885 five seines were operated, three of which were owned in Duluth and the others in Superior. These are fished for about five weeks in the spring, beginning about the middle of May, and they are occasionally hauled during the first two or three weeks of November. About three-fourths of the catch are whitefish, the remainder being chiefly herring, with a few sturgeon.

Hand-line fishing.—Hook-fishing through the ice has been practiced by the Duluth fishermen for some years, and, though not yet important, seems to be increasing. Twelve men fished in this way during the winter of 1884–'85. The fishing begins early in January and lasts till the ice breaks up. Hooks are set separately through holes in the ice, which are arranged in rows and cut 300 or 400 feet apart. One man usually tends about one hundred of these holes. He visits them every day when the weather is suitable, and makes from $1 to $1.50 daily in this way. The catch is chiefly trout, which at this season will bring 5 or 6 cents per pound, although siscowet also are caught. Whole her-

ring are used for bait, and are caught in small gill-nets set in the vicinity.

Set-line fishing.—The use of set-lines is less common than formerly, though a few are still employed by the gill-net fishermen during the season of slack fishing in midsummer, and others use them for a few weeks at the close of the gill-net season. The lines are small, not exceeding five hundred hooks each, and seldom more than two or three lines are tended by one crew. They sometimes fish them in connection with herring-nets, which are occasionally used in November, when it is said that herring are peculiarly abundant, and, if the fishermen could find a market for them, could be taken in enormous quantities, though the demand is now so light that comparatively few are caught.

Dip-nets and other apparatus.—Dip-nets were formerly employed for several weeks in spring at Fond du Lac for catching pike, which were quite abundant at that season, but very little such fishing is now done. There is no spearing of fish about Duluth, and no fykes or trammel-nets have ever been used.

Smoking fish and manufacture of secondary products.—The smoking of fish has never been important, and prior to 1885 was done only by the fishermen themselves for their own use. In the spring of that year a Scotchman built two smoke-houses, and engaged in preparing sturgeon, trout, whitefish, and herring in small quantities, smoking a total of perhaps 10 or 12 tons. No oil, caviare, or isinglass is at present made by the Duluth fishermen, though in former years oil was frequently prepared by the gill-netters, who saved the offal when dressing their fish, trying out, in addition, such species as could not be sold in the markets.

Superior, Wisconsin, and its fishing interests.—Superior is a village of 2,000 inhabitants, on Superior Bay, nearly opposite Duluth, with an excellent harbor. It was for a time the terminus of the Chicago, St. Paul, Minneapolis and Omaha Railroad, but the company has now extended its tracks to Duluth. Strenuous efforts are being made to develop its business interests, and the good harbor facilities offer excellent opportunities for engaging in the commerce of the lakes. The fisheries have never been of great importance, though seines have been hauled along the sandy shores since the earliest settlement of the region, and pound-nets have been set in the vicinity for some years. In 1885 two seines were owned in Superior and used for several months each season for catching whitefish and herring, and three Duluth crews bring seines to the locality and join in the work. There are five pound-nets owned and operated by residents of Superior, who sell their catch to Duluth dealers. In 1884 one of these parties established a fish company for the shipping of fresh and salt fish, but the enterprise was soon abandoned.

20. BAYFIELD, BAYFIELD COUNTY, WISCONSIN, AND THE SHORE BETWEEN SUPERIOR AND THE APOSTLE ISLANDS.

The main shore.—This strip of coast, about 70 miles in extent, is bold and rocky, with small bays and sandy reaches scattered at intervals throughout its length. It is a heavily wooded region, with no post-office-settlements, and, in fact, only two places of human habitation the largest of which is a few miles off the mouth of the Bois Brulé River, where an English colony has established itself to engage in agriculture. At the mouth of Iron River a farm has been cleared, and one man divides his time between agriculture and fishing. The waters abound in fish, and fishermen from both Duluth and Bayfield have pounds and gill-nets along the shore. Four or five crews of Duluth gill-net fishermen occasionally come as far east as the Apostle Islands, but the pound-net fishing from Duluth has thus far not extended beyond the mouth of Iron River, while Bayfield pound-net fishermen have gone as far west as Flag River, only 8 miles distant, and have nets scattered along the coast from there to Bayfield.

The islands.—The Apostle Islands are a group of twenty-three islands of various sizes lying a few miles to the northeast of Bayfield. The largest of these is Magdalene Island, which is about 10 or 12 miles long and 2 miles wide, having about 200 inhabitants, scattered along different coves, about thirty of whom engage in the fisheries from Bayfield. The only village on Magdalene Island is named La Pointe. It is located about 3 miles distant from Bayfield, and is one of the oldest settlements about Lake Superior. For many years it was the leading trading post of the region, and the headquarters of the Hudson Bay Company, who purchased from the Indians salt fish and large quantities of furs. At one time the town is said to have contained upwards of 1,500 inhabitants. Within the last twenty years business interests of all kinds have declined, and to-day they are represented only by the small operations of a single trader, and the population has decreased to fifteen or twenty families.

Fish-dealers were formerly located there, buying and shipping considerable quantities of salt fish, but no dealers had been there for some years prior to 1885; the entire catch going to Bayfield. The other islands are practically uninhabited, though formerly several of the larger ones had one or two houses; in 1885 there were three families on Basswood Island, where there is an excellent red sandstone quarry. A small amount of logging is done here in winter, as well as on one or two of the other islands. During the summer months a majority of the islands are visited by fishermen from Bayfield, Duluth, and Ashland, for engaging in the pound and gill-net fisheries. They build rude shanties to live in during the fishing season, but all take their departure before winter sets in, and leave their places deserted. The waters in the vicinity are at present more extensively fished than those of any other portion of Lake

Superior, and forty-two pound-nets were located among the islands in 1885, besides thirty-one more which were set along the shore of the mainland in the immediate vicinity.

The village of Bayfield.—Bayfield, a village of some note, about 60 miles in a straight line east of Duluth, occupies a desirable location on the east side of the peninsula of Bayfield, 10 miles from its outer extremity and a little to the southward of the Apostle Islands. In 1870 it had a population of about 300, none of them professional fishermen, but the number has increased slowly year by year. The extension of the Chicago, St. Paul, Minneapolis, and Omaha Railroad reached the town in 1883 and gave it a new impetus. Two years later it had a population of 1,250, a majority of whom were dependent upon the fisheries, although a large saw-mill furnished employment to quite a number of men.

Description of Bayfield fisheries.—Owing to its location in the immediate vicinity of excellent fishing-grounds Bayfield has for quite a number of years been largely interested in fishing, and the fisheries occupy the attention of a majority of the citizens. According to the estimates of Mr. Frank Boutin, 25 per cent. of those engaged in the fisheries are Indians and half-breeds, and the remainder are chiefly Canadians and Americans. The fisheries are prosecuted during the entire year, though there is little activity in winter. The season practically opens with the first breaking up of the ice in spring, when the gill-net fishermen, who formerly were the most numerous class, begin catching whitefish and trout among the Apostle Islands and along the shores of the mainland both east and west. By the middle or last of May many of these, with a large number of additional men, begin setting pound-nets about the islands and along the shores for a distance of nearly 100 miles. The pound-net fishery began to be important about 1880, and since then the number of nets has increased annually until Bayfield has become the center of one of the most important pound-net fisheries on the whole chain of lakes. By the last of July the greater part of the pound-net fishing is over, and one after another the nets are removed, the fishermen again starting out with their gill-nets. By the first of October all of the pound-nets have been taken up and gill-net fishing occupies the attention of a majority of the people.

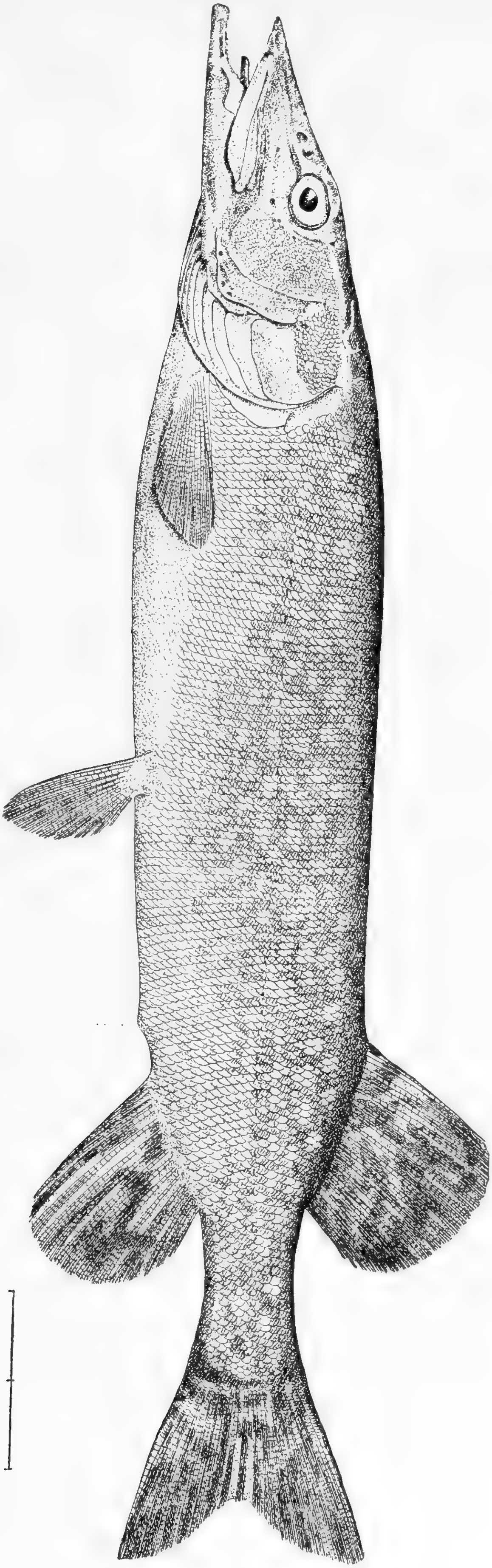
Shipments and preparation of Bayfield fishery products.—Until recently almost the entire catch of fish from both pounds and gill-nets was salted and shipped to other towns on the lakes, including Chicago, Detroit, Cleveland, and Buffalo. No fresh fish were shipped prior to 1876, but from that date until 1883 a small quantity was shipped annually. The introduction of the first collecting steamer, the *N. Boutin*, and the building of the railroad gave an impetus to this industry, and in the spring of 1884 a second collecting steamer was purchased. An important trade in fresh fish was soon developed. During the year 1884 about 60 tons were shipped, nearly all of which went to St. Paul and Minneapolis.

The quantity of salt fish shipped during the same year was 13,000 half-barrels. The succeeding season the fresh-fish trade was much more extensive, and a large percentage of the catch that otherwise would have been salted was packed in ice and sent into the interior, chiefly to St. Paul and Minneapolis. No smoked fish have been put up in the village for shipment, the business being confined wholly to a few smoked by the Indians and other fishermen for family use. About 30 barrels of oil were made by the pound-net fishermen in 1884, but no isinglass or caviare has been prepared since 1878, when Hart Pincus came to Bayfield for the purpose, but after remaining about two months he became discouraged and left the place, taking with him 750 pounds of caviare put up during his stay.

Statistics of fisheries.—In 1885 there were one hundred and eighty-two men engaged in fishing, twenty-seven others in collecting, preparing and shipping the fish, and six others in making barrels and boats for the fish trade; these, including their families, making a total of six hundred and fifteen persons dependent upon the fisheries. If we exclude the twenty pound-nets owned by Ashland parties, there were one hundred and twenty-four pound-nets owned and operated by Bayfield fishermen in addition to two thousand gill-nets and eight seines. The total production of the Bayfield fisheries was 640,000 pounds of fresh fish and 2,192,000 pounds of salt fish, with a total value of $60,080.

Bayfield fish trade.—Two steamers were employed in collecting the fish, one of these fishing for several months in the fall. There were also two schooners engaged in transporting the nets of the fishermen to and from the fishing-grounds, in supplying salt and barrels to the camp, and in bringing back cargoes of salt fish. Three firms, Boutin & Mahan, Rich & Atwood, and Frank Boutin, each had an extensive fishing business, the two former handling both fresh and salt fish and the last-named salt fish only. These parties control the entire catch of the Bayfield fishermen and all of the salt fish of Ashland, sending their tugs and sail-boats for a distance of 30 or 40 miles to the westward and 50 or 60 miles along the eastern shore. They handled in 1885 over 600,000 pounds of fresh and frozen fish and upwards of 22,000 half-barrels of salt fish. The firms furnished barrels and salt, delivering them at the fishing stations to be filled, and freighting the catch to the town. In 1884 the price paid to the fishermen for filling was $3.50 to $4 per half-barrel for Nos. 1 and 2 whitefish, $1.50 to $1.75 for No. 3 whitefish, $2.50 to $3 for trout and siscowet, $1.50 for sturgeon, $1 to $1.25 for herring, $2 for pike, and $1 for suckers. In 1885 the price paid was somewhat less, being $3 to $3.50 for Nos. 1 and 2, $1 for No. 3, $2 for trout, siscowet, and pike, $1 for herring, $1.50 for sturgeon, and $1 for suckers.

Gill-net fishing in open water.—The following account of the gill-net and pound fishing is largely obtained from information kindly furnished by Messrs. Nelson Boutin and J. W. Atwood. Prior to 1870, when Mr.



PIKE (*Esox lucius*).

Boutin came to the region, there had been three or four crews of gill-net fishermen, in addition to the Indians that fished for home supply. From that time the gill-net fishery gradually increased until about 1883, when it began to be superseded by the pound-nets. In 1885 there were about fifteen crews that fished gill-nets exclusively, and twenty-seven others that were interested in both gill-net and pound-net fisheries. The season opens about the 1st of April and continues until the ice forms and prevents the boats from getting out. In the early spring they fish about the islands, and later along the shore between Bayfield and Carp River, remaining till October, when they return to the islands to fish till the close of the season, or, as is frequently the case, proceed to Isle Royale and remain there until stormy winter weather drives them home. As many as thirty boats, with a total of seventy-five or eighty Bayfield fishermen, visited Isle Royale in the fall of 1883, and twenty boats were there in 1884, but as they met with poor success the latter year very few made the trip in 1885.

Three men ordinarily constitute a crew for gill-net fishing, but at least one third of the boats carry only two. They average from forty to eighty nets to the boat. A few of the boats have nets made of fine twine for spring fishing and coarser ones for the trout fishing in the fall. This is especially true of those visiting Isle Royale, but most of those fishing along the southern shore and among the islands have only one set. The nets are 65 fathoms long, and vary from 4½ to 5½ inches in mesh. Some of them are rigged like the old-fashioned Lake Michigan nets, with stones and floats, and the others in the more modern style, with leads and corks. Fifteen or twenty nets constitute a gang, each crew usually having four gangs, and keeping three in the water at one time. The boats are mostly mackinaws, and smaller than those about Duluth. They are worth about $100 each. In former years it is estimated that the average gill-net crew caught between 400 and 500 half-barrels for a year's fishing, but in 1884 the catch did not exceed 300 half-barrels to the boat. In 1885 it was much better, and is estimated at 500 half-barrels.

Gill-net fishing through the ice.—The ice-fishing with gill-nets varies considerably from year to year. It ordinarily begins early in January and lasts for six, eight, or even ten weeks. Two or three men constitute a crew, running from forty to fifty nets. These are set in lines of four nets each, at right angles to the shore; the gangs are half a mile apart, and are left in the water four or five days before hauling. Only fine nets are used, as the sediment would collect too readily on coarse twine, making the nets more noticeable and keeping the fish away. One crew of men ordinarily secures an average of 300 pounds of fish daily, working about four days in a week. The marketable catch is about one-half trout and one-half whitefish, in addition to quantities of suckers and "lawyers," which are commonly thrown away. Some of the crews have small canvas tents or huts mounted upon runners and provided

with stoves, and they move them from hole to hole on the ice, thus protecting themselves from the winter's cold. Others have horses and sleighs for visiting their nets, driving to and from the fishing-grounds, while others still are obliged to go afoot and work without shelter, and, of course, can fish only during moderate weather. Some years, from twenty to twenty-five crews are engaged in net-fishing through the ice, but the fishermen are not disposed to do much at this season, unless necessity compels, and during the winter of 1884-5 only about ten crews were thus employed, and some of these fished only for a short time.

Pound-net fishery.—The first pound located at Bayfield was set by Mr. Boutin, who came here from Ashland in the spring of 1871. The industry was not important until about 1880. Several new nets were purchased in that year, and in 1883 the number had reached twenty-five or thirty, exclusive of those owned by Ashfield fishermen. In 1884 not less than eighty new ones were employed, and the following season ten or twelve more were added. They are set in water varying from 12 to 60 feet in depth, the deepest ones in 1885 being only about 40 feet; but one of the dealers intended making and setting a 75-foot net that fall. The nets are of the ordinary pattern, with forty to eighty rod leaders of 6-inch mesh, a heart of 5-inch mesh, and usually a 28-foot pot of 3-inch mesh. They are provided with tunnels 10 feet square at the mouth, 16 feet long, and having an inner opening of 2 by 6 feet. The nets are usually set between the 15th of May and the 1st of June. Some of the men fish gill-nets before the season opens, and a few continue to fish them in connection with the pounds. Most of the fishing is over by the first of August, and half of the nets are taken out. The remainder are fished until the last of September, when the fishermen fit out for the gill-net fishery. Of late there has been a tendency to prolong the pound-net season, and on September 5, 1885, fully half of the nets were still in the water. In 1884, for the first time, a pound-net was fished in winter, and, though not successful, there was a growing inclination to set pound-nets during the spawning season of the white-fish. It seems probable that within a comparatively short time a majority of the nets will be fished in fall and early winter, as well as at other seasons. The nets are usually purchased from the dealers, some of the fishermen paying cash, but a greater number getting them on credit and paying for them in fish. A few, however, are owned by dealers and other capitalists. These are fished on shares, the net taking from two-fifths to one-half of the catch. Three fishermen usually constitute a crew, fishing from two to five nets, and where more are worked additional men are required. They set their nets about the islands and in the sandy reaches and bays along the main shore, building shanties near by where they camp during the season, and are visited regularly by the collecting boats, which take their fish and furnish them with supplies and provisions. The dealers estimate the average catch

for each pound fished in 1884 at 125 barrels, or about $200. The marketable catch averages 90 per cent. whitefish, 7 per cent. trout, and 3 per cent. sturgeon, in addition to considerable quantities of small whitefish, and a good many sturgeon thrown away. Mr. Boutin thought that the catch of 1885 would not be more than a quarter that of the previous year. This small yield he believed in no way indicated a scarcity of fish, but was accounted for by the fish remaining in the deeper water, where the gill-nets have caught larger quantities than usual. The heavy thunder storms during the pound-net season may have had a decided influence in keeping the fish out of the shoaler water.

Seine fishery.—The seining of fish at Bayfield began about ten or twelve years ago, with small seines 330 to 495 feet in length and 12 to 18 feet deep. They are hauled during the four or five weeks between the 5th of June and the middle of July. The catch is principally whitefish, though considerable quantities of herring are also taken, but, owing to the small demand, few are saved. The fishing is at present chiefly in the vicinity of Bark Point and Sand River, along the western boundary of Ashland Peninsula. The fishermen seldom make blind hauls, as in other places, but have a man on the lookout on some elevated point of land to watch for fish, and when a school is seen it is surrounded by the seine and hauled ashore. The average catch is estimated at about 100 half-barrels of salt fish, though formerly it is said to have been three times that quantity. In 1885 there were thirteen seines owned at Bayfield, but only eight or ten of them were fished to any extent during the season, and the catch, owing to the absence of the fish from the shore waters, was unusually light.

Hand-line fishing through the ice.—There is considerable hand-line fishing, or "bobbing," as it is locally called by Indians and others, through the ice in winter. The former take fish for their own use, but a few of the whites make it a business, freezing their catch and selling to Duluth dealers. The catch is usually small, but sometimes a man will get 300 to 400 pounds in a day.

Spearing.—In the morning each "bob" fisherman, by means of a little home-made wire spear used through a hole in the ice, provides himself with herring enough to serve as bait for the day's fishing. The spearing of trout through the ice by the Indians is also quite common in certain localities. They usually have a brightly-painted decoy resembling a fish, which they dart into the water through an opening in the ice, and the trout are attracted toward it and speared.

Other fisheries.—No trammel-nets have been fished in the locality, and fykes have been employed in only one instance, this being in the spring of 1884, when a small number were fished at the mouth of one of the larger streams without success.

21. ASHLAND AND VICINITY, ASHLAND COUNTY, WISCONSIN.

Description of the town.—Ashland, at the head of Chaquamegon Bay, about 16 miles from Bayfield, was settled about 1865, but continued small and unimportant until railroad communication was established between it and the interior. In 1885 it was a town of 5,000 inhabitants, with two railroads, and is a favorite summer resort for the people of the northwest. Its business interests are largely confined to lumbering and the shipping of lumber and iron ore from the interior, but its advantageous location makes it available as a leading port for lake traffic.

Origin and history of the pound-net fishery.—The fisheries are relatively of very little importance, as their location at the head of the bay necessitates a long trip to the fishing-grounds. The fishermen find it more convenient to locate at Bayfield, and those inclined to this occupation have, as a rule, moved to that place. Though of little importance as a fishing town, Ashland, according to Mr. Nelson Boutin, of Bayfield, deserves the credit of having had the first pound-net fished in the waters of Lake Superior. This, he states, was set by a man named St. Germain, in 1869, but the catch was quite small. In 1870, Mr. Boutin came to Ashland with pound-nets from Lake Michigan, where he had been fishing in various localities along the western shore between the northern end of Green Bay and Chicago. He set three nets along the shore in the immediate vicinity of the village, and in three weeks caught 1,100 half-barrels of large fish, throwing away as many more of a size that would now be considered marketable. Another fisherman put in a pound-net at Ashland the same year. The next year, finding the location inconvenient for the prosecution of the fishery, Mr. Boutin and his brothers, who were all experienced and energetic fishermen, removed to Bayfield, though for several years they set and fished a few pound-nets near Ashland, in addition to those at Bayfield and the Apostle Islands. From that time to the present other parties have set a few pounds in the vicinity, residents of Ashland have fished in the upper bay and about the Apostle Islands, and two or three firms have at various times bought fish from Ashland and Bayfield fishermen and shipped to the interior. In the year 1885 there was one firm, the Ashland Fish Company, sending boats to the Apostle Islands and along the outer shores, buying fresh fish from the fishermen and shipping to St. Paul and to smaller towns in Wisconsin and Minnesota.

Present condition of the Ashland fisheries.—The Ashland Fish Company is also engaged in fishing, buying its apparatus at Bayfield. In 1885 the firm owned and operated twenty pound-nets, selling the salt fish to Bayfield parties and landing the fresh fish at Ashland for shipment. Another resident of the town fished two pound-nets, but the catch was largely sold to Bayfield dealers. In addition, three gill-net crews, residents of the town, fished during a greater part of the summer, disposing of their catch at Bayfield. The total amount of capital

invested in the fisheries of Ashland in 1885 was $10,200. In 1884 about 100,000 pounds of fresh fish were shipped from Ashland, in addition to a considerable quantity from Bayfield, where the firm located for a few months in the fall. In 1885 the product amounted to 327,000 pounds, of which considerably over one-third was fresh trout, and nearly one-third fresh whitefish, and their value was $11,350.

The settlement of Odonah.—Odonah is an Indian reservation, of 800 to 1,000 souls, located 16 miles to the eastward of Ashland, near the mouth of Bad River. It contains a settlement of thirty or forty families, the remaining population being scattered over the reservation and engaged in farming on a small scale. Formerly some of them went to Bayfield and worked for wages in the fisheries from that place, others occasionally fished a little for home supply near the mouth of the river, and five or six crews went to the Apostle Islands to fish for a week or two, each man salting 2 or 3 half-barrels of fish before returning home. During the past few years the Indians have been less interested in fishing, and in 1885 not more than 2,000 or 3,000 pounds in all were taken by them.

22. ONTONAGON AND VICINITY, ONTONAGON COUNTY, MICHIGAN.

Description of the coast.—The stretch of coast between Chaquamegon Bay and Houghton, though about 130 miles in extent, contains only the single village of Ontonagon, and elsewhere, with the exception of two families at Iron River and one family at Nonesuch, is wholly uninhabited. It is similar in character to the coast farther west, having shores of red sandstone, interrupted by small sandy bays and reaches near the mouths of the larger rivers, the principal ones of which are the Montreal, the Presque Isle, and the Ontonagon. The immediate vicinity of the shore is covered with small trees of various species, and the land farther back is heavily timbered with large pines. The soil is said to be quite fertile and when once cleared the land is capable of supporting a fair population.

The fishing along the uninhabited portion.—Fish are abundant along the shores, but the fishing is wholly limited to pound-nets and gill-nets owned and operated by fishermen of Bayfield, who build shanties in the bays and sheltered coves, and remain there during a great part of the spring and summer, selling their catch to the collecting steamers belonging to the fish dealers of Bayfield. In the summer of 1885 there were between Bad River and Ontonagon thirty-seven pound-nets owned by Bayfield parties, and 17 miles further on, at the mouth of Sleeping River, was one pound-net owned by Ontonagon fishermen.

Ontonagon and its fisheries.— Ontonagon itself has about 1,500 inhabitants, and is situated at the mouth of Ontonagon River, about 75 miles from Bayfield. It formerly had extensive mining interests, and its lumbering business is now important. It has no railroad facilities, being 50 miles by stage road from L'Anse, the nearest railroad station. Its

fisheries have never been important, though pounds, gill-nets, and seines have been fished in the vicinity, and there have sometimes been eight or ten gill-net crews during a single season. In 1884 a small steamer, the *Ella Corgan*, of about 10 tons burden, worth about $1,200, and with a crew of three or four men, was used in the gill-net fishery, but met with poor success, most of her nets being lost. The catch did not exceed 250 barrels. The next season she was laid up. There are now three seines, from 330 to 495 feet in length, fished for a number of weeks, two crews engage in the gill-net fishery, and one of the fishermen owns a pound-net located about 15 miles east of the village, near the mouth of Sleeping River. The catch amounted to about 100,000 pounds of round fish, more than half of which were whitefish. A small quantity of these were sold fresh to supply the village trade, and the remainder were salted and shipped, chiefly to Chicago. The value of the products to the fishermen was $4,245.

23. KEWEENAW PENINSULA, KEWEENAW COUNTY, MICHIGAN.

Geographical characteristics.—The peninsula of Keweenaw, containing portions of Houghton, Keweenaw, and Baraga Counties, extends in a northeasterly direction from the mainland to about the center of Lake Superior. It is about 25 miles wide at its base and 60 miles long, and the upper portion is practically an island, as it is separated from the remainder by Portage River and Lake, and a ship-canal several miles in length, reaching through to the opposite shore. The peninsula is famous for its excellent copper mines, which are, perhaps, the largest and richest mines of that class in the world. The land is rough and rocky, and the shores are, as a rule, quite bold, with few sandy bays or reaches, though there are some good harbors, and others that are partially sheltered.

Towns and railroads.—The Marquette, Houghton, and Ontonagon Railroad extends as far up the peninsula as Houghton and Hancock, which together have a population of about 6,000, and are the leading commercial centers of the peninsula. A narrow-gauge railroad extends from this point to the famous Calumet mine, but the villages beyond are reached only by stage and steam-boat. The only settlements of importance along the coast are the following: Eagle River, the county seat of Keweenaw County, a village of 700 or 800 inhabitants, with a small harbor, interested chiefly in mining and in trade with the miners of the interior; Eagle Harbor, somewhat smaller, with several stores, and a fair harbor, where materials are landed for the mines at Copper Falls, 3 miles distant; Copper Harbor, a settlement of 150 inhabitants, at the end of the peninsula, with an excellent harbor and a saw-mill; and Craig, a fishing village of thirty or forty families, at the mouth of Portage River, on Keweenaw Bay. There are in addition several villages of greater or less size, such as Calumet and Lake Linden, which, being inland, have no interest in the fisheries.

Fishermen.—The fishermen of the region are mostly foreigners, many of them recent immigrants from Finland, and the majority of the remainder French Canadians and Swedes, with a few Indians and half-breeds. They are scattered about at the different harbors, as follows: Nineteen at Houghton and Hancock; four at Delaware Mine; eight at Eagle River; six at Eagle Harbor; four at Calumet, and nearly all of the remaining sixty-four at Craig, at the mouth of Portage River, which is settled wholly by fishermen, and is the only settlement in the region where any considerable percentage of the people are interested in fishing.

Apparatus and methods of the fisheries.—The gill-net fishery takes the lead, and there were fifty-three boats, carrying two men each, employed in this way during the greater part of 1885, in addition to five crews of Indian half-breeds that fished for home supply. In 1884 there were six pound-nets fished in these waters, and the number was largely augmented the next season, one of them being owned by parties from Marquette. The fishermen usually camp along the lower portion of the peninsula, especially on the shores of Keweenaw Bay, during the spring and early summer, moving towards the outer headlands in the fall to engage in the trout fisheries, and some crossing to Isle Royale, where two of the pound-nets and a gill-net crew were fishing in 1885. They erect comfortable shanties in the vicinity of their fishing grounds, and some of them arrange to have their families with them during the fishing period.

Trade.—Only one firm, the Houghton Fishing Company, is extensively interested in the purchase and shipment of fish, though another party at Craig ships small quantities. A few of the fishermen ice their fish for shipment to the larger markets, but a majority sell their catch, both fresh and salt, to peddlers, who distribute them among the miners of the peninsula. The Houghton Fishing Company has no regular collecting boat, but charters a steamer every three or four weeks to make the round of the fishing stations, purchasing such fish as may have been secured and leaving with the fishermen salt and barrels for curing their future catch.

Statistics.—The fisheries for 1885, if we include the shore as far west as Pine River, occupied the attention of 130 men, with 2,295 gill-nets, 10 pound-nets, and 10 seines, the catch amounting to 444,000 pounds of fresh and 4,206 half-barrels of salted fish, valued altogether at $34,170.

Gill-net fishery.—Gill-nets have been in use since the first settlement of the region, and are still more extensively employed than any other form of apparatus. Each boat has forty nets, worth about $10 apiece. The nets average 450 feet long and 15 meshes deep, with meshes $4\frac{3}{4}$ to 6 inches. Formerly all were rigged with floats and stones, but about 1875 corks and leads were introduced and have now superseded the others. The fishing begins early in May, or as soon as the ice will permit, and continues until the middle or last of November. The larg-

est catches are made between September 25 and November 1, when the trout are quite abundant. Whitefish are taken in considerable numbers early in May, and in fair quantities throughout the summer. The catch in 1884 averaged about 250 barrels to the boat, one-half of which were whitefish and the rest trout and siscowet. The next season the catch was slightly better and averaged 300 packages to the boat. The boats used are chiefly mackinaws, and are better built than those formerly employed. Few parties are interested in gill-netting through the ice, as the ice in this region is not sufficiently safe to warrant any extended business. Fifteen or twenty men fish a few nets at intervals during the winter, but their catch is small.

Herring gill-net fishing is not extensive and is confined almost exclusively to the settlement at Craig, where about fifteen boats participate in it for two or three weeks in November and December. Each crew usually fishes about five nets, 325 feet long and 22 meshes deep, the catch averaging from 1½ to 2½ tons to the boat. The fish are frozen and packed in straw, where they are kept to be sold in small quantities during the winter months.

Pound-net fishery.—Pound-nets, according to Mr. Joseph Bertrand, were introduced into the region at Franklin River, about 1874, by Mr. Stein. Since that time they have been used to a greater or less extent every year, though never so numerously as at present. In 1884 there were six pound-nets on the peninsula, and the next year the number had increased to ten. They were set in depths varying from 12 to 40 feet, the majority of them being in 25 to 28 feet, and cost about $300 each when placed in the water. The fishing season lasts from the middle of May to the middle of November. The fishermen, in addition to tending the pound-nets, run at the same time a gang of twenty-five to thirty gill-nets.

Seine fishery.—Seines were formerly more abundant than at present, and seine fishermen were often successful in making large catches. In 1885 there were eleven seines in different portions of the peninsula, the majority of them being used in the lower portion of Keweenaw Bay. The fishing season is June and July, and the catch is about half whitefish and the remainder trout and siscowet. The seines are from 247 to 330 feet long, and 12 to 15 feet deep. They are usually home-made, and of a mesh so small that even the tiniest minnows cannot pass through. They are fished chiefly by foreigners, who salt the large fish, using the smaller ones for bait or throwing them back into the water. It is estimated that, during 1885, the average seine caught about 2,500 pounds of fish.

Fyke-net fishing.—A few fykes are owned by fishermen at Portage Entry and fished in the mouth of the river for wall-eyed pike and pickerel, for several weeks each season.

Trawling.—The foreigners coming to the region have brought with them the method of trawl-line fishing employed in Europe, and about

eight of the gill-net crews now use small lines, averaging, perhaps, five hundred hooks each, which they fish in connection with their gill-nets during the summer months. They keep these in the water most of the time, visiting them about three times a week to remove the fish and rebait the hooks.

Secondary products.—Sturgeon are not abundant, and for this reason no caviare or isinglass is prepared. Formerly a small quantity of fish-oil was made, but for the past two years none of the fishermen have saved any. No fish are smoked, except by fishermen for home supply, and the quantity prepared for this purpose is insignificant.

24. L'ANSE AND BARAGA, BARAGA COUNTY, MICHIGAN.

Physical features.—The little sheet of water known as L'Anse Bay is formed by the alternate contraction and expansion of Keweenaw Bay at its inner end. It is nearly circular, and about 6 miles in circumference, having several small tributary streams, which are resorted to by sportsmen from other places, who altogether catch several thousand pounds of brook-trout each season with hook and line in these waters.

The villages and their inhabitants.—The village of L'Anse, the county seat of Baraga County and a railroad center, is located on the south-eastern shore of the bay, and the new settlement of Baraga is directly opposite upon the northwestern shore. Considerable business was formerly done at L'Anse in the way of iron mining, but the supply of ore grew so low that the mining ceased to be profitable and was abandoned. The population is about 1,000, mostly half-breeds and Indians, many of whom are engaged in fishing. The present occupations are quarrying and lumbering. Baraga has sprung into existence since 1882. Its only business is lumbering, and it has several large saw-mills.

Decline of the fisheries.—Fisheries of greater or less extent have been carried on in L'Anse Bay since the first settlement was made upon its shores, many years ago; but of late years the catch has been rapidly decreasing, owing, it is supposed, to the sawdust and waste wood from the mills, which, being thrown into the waters, becomes water-soaked and covers the bottom, thus preventing the fish from finding sufficient food. In the summer of 1880 the gill-net fishermen made good profits, but since that time there has been a great scarcity of fish.

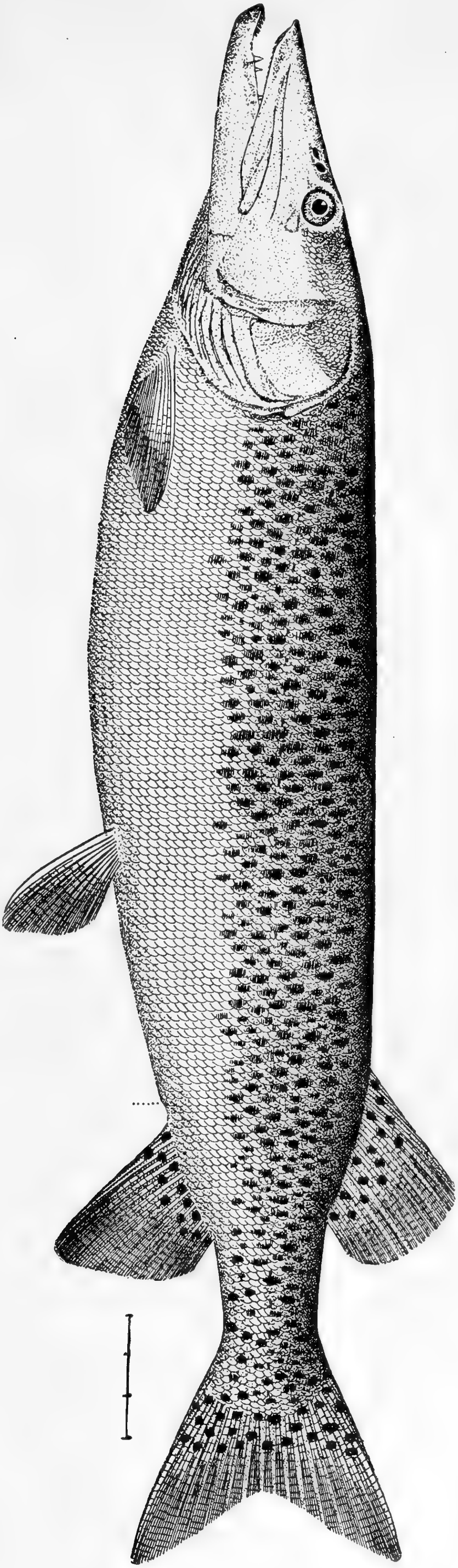
Statistics.—In 1885 there were seven pound-nets fished by fourteen men and worth, with shore houses and accessory apparatus, $2,620. Thirty-eight gill nets, worth, with the boats used in setting them and the drying-reels, $512, were used in the summer and fall, and twenty gill-nets, worth, including necessary ice-boats, $280, were fished under the ice in the winter of 1884–'85. Forty Indians, with apparatus worth $440, fished with hand-lines under the ice, and ten more made a living by spearing trout, their shading blankets, spears, and decoys having a total value of $65. The dip-net fishing employed two men, with apparatus worth not more than $25.

The total number of fishermen in L'Anse Bay and the immediate vicinity was twenty-two in the open season, and fifty others during the winter. For about a month in the summer, during the height of the fishing, the number rose to thirty-five. The amount of capital dependent upon the fisheries was nearly $4,000, and the products in 1885 had a total value to the fishermen of $7,496.33. The total quantity of whitefish, as sold, was 59,914 pounds fresh and 28,000 pounds salted; trout, 54,720 pounds fresh and 1,750 salted; herring, 14,280 pounds fresh and 5,250 salted; lawyers, 6,811 pounds; suckers, 6,455 pounds; brook-trout, 2,856 pounds; sturgeon, 4,760 pounds; pike and pickerel, 1,904 pounds; besides an occasional black bass or perch, making a total production of 186,700 pounds dressed.

Preparation and trade.—The only fish salted are a portion of the pound-net catch. These are all shipped to Detroit and Chicago. They sell for about $4 a keg, and are 80 per cent. whitefish, 15 per cent. herring, and 5 per cent. trout. There are no sturgeon or pike salted. The fresh fish are either sold in the market at L'Anse, peddled about in the vicinity, or used in the families of the fishermen. There are seven or eight persons who have fish stands in the market, occupying about one-third of the entire building. Eight or ten Chippewas peddle fish irregularly from house to house.

Proportions and prices of the different species.—Fifty-seven per cent. of the fresh fish in the summer of 1885 were whitefish, 10 per cent. trout, 15 per cent. herring, 5 per cent. suckers, 5 per cent. sturgeon, 3 per cent. brook-trout, 3 per cent. lawyers, and 2 per cent. pike and pickerel. In 1884 the proportions were about the same, except that there was a larger percentage of herring. Formerly there was a noticeable percentage of perch, but now only an occasional one is taken. The price per pound was 4 cents for whitefish and trout, 3 cents for herring, 5 cents for sturgeon, 20 cents for brook-trout, and 2 cents for pike and pickerel. Suckers are sometimes sold, but are usually given away to be used as food or as a fertilizer on land. The lawyers, which are called in the vicinity "larch" or "dogfish," are all given away to the Indians to eat. In winter fewer species are taken, and the proportions are quite different, being, in 1884-'85, about 80 per cent. trout, 10 per cent. whitefish, 7 per cent. lawyers, and 3 per cent. suckers.

Pound-net fishery.—The first pound-net was introduced in the vicinity of L'Anse Bay by Captain Bean many years ago. The number has varied considerably from time to time, reaching eight in 1884 and seven in 1885. About the year 1875, parties from Lake Erie set sixteen to twenty pound-nets along the shore between L'Anse and Portage Entry, but were compelled by the local fishermen to take them up. Some claim that their excessive fishing produced the scarcity of fish which has been felt of late years, but Mr. Earl Egerton, who is thoroughly posted regarding the fisheries of the region, states that the intruders were very unsuccessful, catching only a small quantity of fish. Up to



MUSKELLUNGE (*Esox nobilior*).

about 1875 the nets used were of the old style, with short funnels, but during the next ten years the long funnelled form was most prevalent. The size of mesh in the pot or bowl is from $2\frac{1}{4}$ to 3 inches. The seven nets are of different sizes, the length of leader varying from 600 to 1,000 feet, averaging 800 feet, the depth of pot from 26 to 45 feet, averaging 30 feet, and the surface size of pot from 14 to 34 feet square, averaging 25 feet. The pound-nets have an average value of $300, and seven skiffs and five fish-houses are used in connection with them, the skiffs being worth $25 each, and the shore-houses, including pile drivers and scoops, $75 each. Most of the nets are placed at right-angles with the shore, but several are set obliquely. The fishing season is from the 1st of June to the middle of October. Heretofore there has been no winter pound-net fishing, but Mr. Crebassa proposed trying the experiment of leaving in the smaller of his two pound-nets in the winter of 1885–'86. He also intended to set a new net on the other side of the bay north of L'Anse. In 1884 the eight pound-nets yielded 1,200 half barrels of salt fish, and 80,000 pounds of fresh fish, but for the seven in 1885 the average catch was smaller, and though 70,000 pounds were sold fresh only 350 half barrels were salted.

Summer gill-net fishery.—The gill-net fishing was once quite extensive and remunerative. Fish could be obtained in abundance during three periods of each year—between May 1 and June 15, between July 20 and September 15, and between November 15 and December 25. For some years this has not been the case, and the sixty nets fished by seven men with three boats in 1884 were succeeded in 1885 by twenty-eight, fished unsuccessfully by the pound-net fishermen. Between thirty and forty nets were put in by fishermen from Cleveland, Ohio, but about half of them had been taken away by September 1. The twenty-eight local nets were handled by five men with two mackinaw boats. They were pound-and-a-half nets, 60 fathoms long and 14 meshes deep, with a $4\frac{1}{2}$-inch mesh. Most of them were rigged in the old-fashioned way, with stone and float, but a few had leads and corks. The entire catch for 1884 was only 100 pounds to the net; and that for 1885 not much better, being only 150 pounds. In the prosperous days of the business it was not unusual to get as much as that to a net every morning.

Winter gill-net fishery.—Four of the men who used gill-nets in summer have made a practice of fishing under the ice in the months of January, February, March and April. When engaged in this work they use a shelter made of canvas stretched upon a frame. This is mounted upon runners, and has in it a sheet-iron stove. The catch with twenty nets was only 1,500 pounds for the entire season.

Gill-net fishing for herring.—From June 15 to July 15 and from October 15 to the end of November the herring fisheries are carried on with 75-fathom nets, 35 meshes deep, having a $2\frac{1}{2}$-inch mesh, rigged with stone and float, and worth about $12. The catch in 1884, by six men,

with two mackinaw boats and six nets, was 5 tons; in 1885, with an additional boat, two additional men, and four more nets, it was 10 tons. Mr. Egerton says that the "herring" caught in June and July are really young white fish.

Seining.—Seines were formerly used a great deal in the vicinity, but have now been abandoned. In 1884 one was hauled near the wharf at L'Anse, and during the season 4 or 5 tons of fish were taken, almost exclusively herring. The party who was fishing with it left the locality, and the following year there was no seine fishing.

Bobbing.—From January to April about forty Indians go bobbing, that is, fishing with hook and line through the ice. Each fisherman uses a single line, with a spoon hook, and has a small piece of herring or sucker for bait. The apparatus, together with his spears for obtaining fresh supplies of bait, and his tools for cutting the ice, he carries with him in a little tent-covered sled. The outfit for one fisherman, including the hook and line, is worth about $11, and the average catch for the entire season is about 1,000 pounds to a man. This fishery has been carried on in L'Anse Bay for at least fifteen or twenty years.

Spearing.—About ten additional Chippewas, after having worked during the summer at lumbering and loading vessels, make a practice of spearing trout during the season when the ice is sufficiently strong to bear them. The trout spearer, after having cut a hole in the ice, throws a blanket over his head, so that he can see into the water, and to attract the fish moves up and down below the surface a little decoy herring. The spear used is made of iron, with three barbed prongs and a wooden handle 20 feet long. The average catch per man is about 1,500 pounds.

Other fisheries.—No trammel-nets have been set in the bay. In 1883 hoop-nets were tried for catching herring, but they did not succeed and the fishery was soon abandoned. There are two white men who fish with dip-nets at the mouth of the Fall River, in L'Anse. The fishing is carried on only in the spring, as suckers, which are the object of pursuit, are not considered edible at other seasons of the year. The nets have a three-quarter-inch mesh and hang 4 feet below the pole, which is 6 feet long. About 1,000 pounds in all are taken by the two men. As far as can be learned, no set-line fishing was ever done.

25. HURON BAY, HURON COUNTY, MICHIGAN.

Nature and location of fisheries.—Huron Bay is a deep irregular indentation in the lake shore, just eastward of the entrance to L'Anse Bay. Two pound-nets are fished in it by a crew belonging at the hamlet of Skanee, and there are two gill-net crews on the Huron Islands. The fishing is carried on with both kinds of apparatus from May to November.

Statistics.—The products of the pound-nets in 1884 were three-quarters whitefish, one-twelfth muskallonge, and the rest trout, but the gill-net fishermen get two thirds trout and but one-third whitefish. The quantity of whitefish was larger in 1885, while the trout decreased in number that year. Two-thirds of the catch in 1884 and three-quarters of it in 1885 was salted, and the remainder was sold fresh. The total yield in the latter year was 58,000 pounds, valued at $2,460.

26. MARQUETTE, MARQUETTE COUNTY, MICHIGAN.

Description of the town.—Marquette, the county seat of Marquette County, is on a good harbor, known as Iron Bay, on the south shore of Lake Superior, about 170 miles from its eastern extremity. It was first settled by miners, about 1845, and, being located in the vicinity of extensive iron mines, practically controls the trade in iron ore for northern Michigan. It has three large ore docks, with furnaces and foundries for utilizing the ore. In 1885 it had a population of about 6,000 people, one railroad and several lines of steamers.

Situated as it is, in the vicinity of excellent fishing-grounds, one would expect to find the fisheries of considerable importance, but when compared with other industries of the town they are quite insignificant.

Extent and methods of the fisheries.—The fishermen are mostly Americans, who have fished for some years. The fishing is at present confined to two small steamers and two sail-boats, fitted with gill-nets for whitefish and trout, three seines used in the vicinity of the village for herring and small whitefish, and five pound-nets fished for herring and whitefish. The catch, which in 1884 amounted to 390,000 pounds, was landed fresh; 45,000 pounds being afterwards salted and the remainder shipped to Chicago, Denver, Kansas City, and interior towns of Michigan. The fishing is almost exclusively for whitefish, trout, and siscowet; the first named, according to Capt. R. Peters, being most abundant in May, and again in August and September, but disappearing almost entirely when the trout arrive in October.

There are no spawning-grounds for whitefish, except about Standard Rock, where a few fish-eggs are taken. Trout occur in considerable numbers during the spring and summer, but they are most abundant in October, when they visit the shore waters for the purpose of spawning. Marquette is the only locality on Lake Superior where siscowet are extensively sought by the fishermen. These fish are said to be abundant during the entire year, on muddy bottom, in from 70 to 100 fathoms of water, where they spawn in December. The fishermen usually keep one or two gangs of nets on these fishing-grounds at all times, and in November and December, when other fish are scarce, they set all their nets in deep water for this species. The whitefish here average about 2½ pounds each, netting the fishermen from 4 to 6 cents per pound. The trout and siscowet average about 3 pounds, and bring from 3 to 5 cents per pound.

Statistics.—In 1885 there were twenty-two men, with three hundred and fifteen gill-nets, five pound-nets, and three seines, engaged in fishing from Marquette, the catch amounting to 387,680 pounds, made up as follows: 101,400 pounds of whitefish, 163,810 pounds of siscowet, 96,320 pounds of trout, 21,150 pounds of herring, and 5,000 pounds of other fish. Of these, 49,250 pounds were salted, the remainder being sold fresh. No fish are smoked at Marquette, and no oil, isinglass, or caviare is prepared. The total value of the products was $13,250.

Gill-net fishery.—Gill-nets are more extensively used than any other form of apparatus, and have been fished from the earliest settlement of the place, though formerly in limited quantities. In 1864 there were but two boats, and in 1873 there were still only three or four crews. In 1874 the first steamer, the *Siscowet*, was brought to the locality and engaged in the gill-net fishing for a short time. In 1878 a second steamer was employed. In 1880 Detroit fishermen brought another steamer to the harbor, and in 1881 there were four steamers from Detroit and two local steamers. In 1885 there were two steamers, both owned and fished by residents of Marquette, and, in addition, two sail-boats, with crews of two men each. The fishing begins as soon as the ice will admit in the spring, and continues till late in December and occasionally till the middle of January. At first the nets are set wherever open waters can be found, but later they are usually placed in 40 to 90 fathoms of water almost anywhere along the shore, there being no special fishing-grounds. The catch, according to Captain Peters, is about 40 per cent. siscowet, 35 per cent. trout, and 25 per cent. whitefish.

Pound-net fishery.—Pound-nets were never more extensively employed than in 1884, when seven nets were fished within a few miles of Marquette. The first pound-net was brought to the locality from Lake Ontario, in 1865, and set within half a mile of the village. In 1872 two or three more pound-nets were brought to the place, since which time this fishery has been continuously prosecuted. The catch in 1884 amounted to about 2 tons of fish to the net, but in 1885 it did not exceed three-quarters of a ton. The catch is about two-thirds whitefish and the remainder herring and trout in about equal quantities. Suckers are taken in considerable numbers, but are seldom saved.

Seine fishery.—The seine fishing is of little importance, though seines have been used for about thirty years. There are three at the present time, of very small mesh, fished in the harbor during the months of June and July, the catch, which amounts to about 50 barrels apiece, being mostly young whitefish.

Other fisheries.—Set-lines were formerly fished by the boat-fishermen, in connection with their gill-nets, each boat being provided with one gang of either one or two hundred hooks, but for the last five or six years none have been employed.

There is little ice-fishing and no herring-netting of importance.

27. AU TRAIN, ALGER COUNTY, MICHIGAN.

Character of the fisheries.—Au Train, situated a few miles west of Grand Island, is a very small settlement of charcoal burners and lumbermen. The fisheries are of little importance. A pound-net was fished there in 1884 and another in 1885. In 1885 there was one gill-net boat, with two men and fourteen nets, but the catch was small. A wood-cutter fishes a few set-lines for awhile in winter and at odd times in summer. In winter about a dozen half-breeds, with hand-lines and spears, fish for trout through the ice. The hand-line fishing occurs only during the month of March, the catch for each man during that period being about 1,200 pounds. The spearing is carried on from January to April, with long spears having a flat four-pronged iron head. As in other places, little wooden decoys are used to attract the fish.

Products.—The total yield of the fisheries of the village in 1885 was about 26,000 pounds, having a value of a little less than $1,800. In summer a few thousand pounds are salted, but the winter trout catch is all sold fresh, most of it going to Marquette, where it brings 8 cents a pound. When a stray whitefish is caught through the ice it brings a much higher price.

28. MUNISING AND GRAND ISLAND, ALGER COUNTY, MICHIGAN.

The village and its people.—Munising is a village of possibly 200 inhabitants, situated at the western end of the Pictured Rocks, on a little bay excellently sheltered from northerly storms by the hills of Grand Island. It is within a few miles of the Detroit, Mackinac, and Marquette Railroad, and its harbor is one of the best on Lake Superior. Some eight or ten years ago an iron furnace went into operation in the village, and there was another a few miles away. These, together with several sets of charcoal-kilns gave employment to a considerable number of people, but in two or three years the low price of iron led to the abandonment of the smelting and charcoal burning, and the population fell to its present insignificance. The soil is barren, and the people now derive their principal livelihood from hunting, berry-picking, and lumbering.

Fishing by non-residents of Munising and Grand Island.—The vicinity is much resorted to by sportsmen and anglers, who each year catch many brook-trout. Small fisheries are carried on for profit in the bay, both by residents and by fishermen from other places. The only noticeable fishing of this kind by non-residents in the last two or three years has been by parties from Detroit. An ice-house was built on the wharf at Munising in 1883, and steamers visited the region in 1884, but not in 1885.

Statistics of local fisheries.—About twenty men are actively interested in the local fisheries of Munising and Grand Island, with capital to the amount of something less than $3,000.

The total production in 1885 for all kinds of fishing by local fishermen was nearly 100,000 pounds, of which two-thirds were whitefish and over one-fifth trout, with a total value of $3,770. Over a third of the catch was salted and shipped into the interior, and a few hundred pounds, mostly trout, were smoked by the keeper of the East Channel Light-house, on Grand Island, for himself and his neighbors. The rest was used fresh in the village or sold in neighboring settlements or lumber camps. Suckers and lawyers are not made use of.

Pound-net fishery.—The first pound-net was set in the bay about the year 1865 by Captain Bean, and that form of apparatus has been fished there ever since, there being five in the bay in 1884 and 1885. They have a mesh averaging from $2\frac{1}{2}$ to $3\frac{3}{4}$ inches. Three of the nets are run out from Grand Island and the others from the mainland, one on each side the village.

Gill-net fishery.—Gill-nets were introduced among the Indians and half-breeds of this vicinity many years ago, and a few are used in the village now, there being, in 1885, four in winter and about a dozen in summer. They are 495 feet long and 16 meshes deep, with a $4\frac{5}{8}$-inch mesh. Six reels are used for drying the nets.

Spearing.—Two of the pound-net fishermen, two other white men, and a dozen Indians or half-breeds devote considerable time to spearing trout when the bay is frozen over. The spears have handles 20 feet long, and in most cases flat four-pronged iron heads; although another form, called the box-spear, is also used, which has four points arranged in the form of a square and a fifth one in the center. The outfit for each man, including spear, blanket, and decoy, is worth about $6.50.

Other fisheries.—Hand-lines are used in winter by three or four Chippewas to catch fish for their own families, but no set-line fishing has been done. A seine was hauled about 1870, but there has been no seining since that time.

29. GRAND MARAIS, ALGER COUNTY, MICHIGAN, AND VICINITY.

Description of the locality.—The coast-line from Grand Island to Whitefish Point, a distance of 80 or 90 miles, is for the most part bold and rocky, with no harbors, except at Grand Marais, a village of 200 or 300 inhabitants, extensively engaged in lumbering. It is 25 miles from Seney, the nearest railroad station, and thus far has only one steamer, which makes tri-weekly trips from Sault de Ste. Marie. The shore, if we exclude this village, is practically uninhabited, except by light-house keepers and the crews of the life-saving stations located at intervals throughout its length.

Character of the fisheries.—The fisheries are of little importance, and are confined to gill-netting, with sail-boats, and a little seining. At Grand Marais village there are two gill-net boats, with two men each, and one seine, in addition to four seines and a gill-net boat used by Indians and the crews of the life-saving stations.

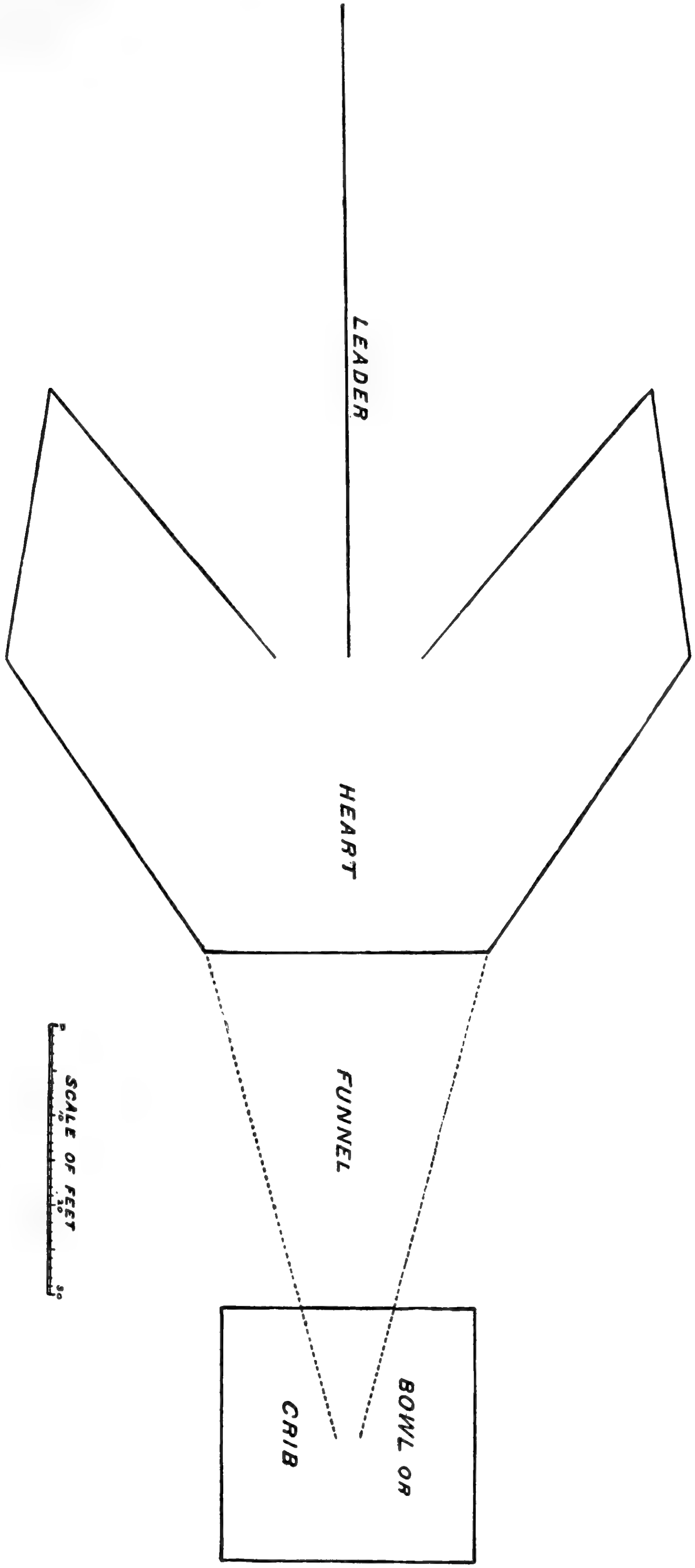


DIAGRAM OF THE TYPICAL LAKE POUND-NET.

About half the catch, which is made up almost exclusively of whitefish, trout, and herring, is salted, and the remainder is sold fresh to the mill operatives and other residents of Grand Marais, with the exception of small quantities purchased by collecting steamers from Sault de Ste. Marie or shipped there fresh in ice on the freighting steamer.

Statistics.—In 1885 there were along this stretch of coast six professional fishermen, using gill-nets and seines, and twelve others that should more properly be considered as semi-professional, as they fished with seines only at intervals. The catch amounted to 22,000 pounds of whitefish, 20,500 pounds of trout and siscowet, 8,000 pounds of herring, and 6,500 pounds of other fish, and was valued at $2,080.

30. WHITEFISH POINT, CHIPPEWA COUNTY, MICHIGAN.

Importance of fishing interests.—Whitefish Point at the western entrance to Whitefish Bay, about 40 miles west of Sault de Ste. Marie, is a favorite fishing station, and the waters of its vicinity have been fished regularly for more than twenty years. In fact, if the fishery interests were taken away, nothing would remain of the settlement. Only a few families remain in winter, and they employ their time in making and mending nets and getting things in readiness for the year's fishing, which begins early in May and continues till late in November.

History and present condition of the fisheries.—The region was first visited by fishermen from Sackett's Harbor, New York, who, provided with boats and gill-nets, came there in 1863, salting their catch, which consisted chiefly of whitefish, and sending it to Detroit and Cleveland, except such portion as they were able to dispose of to the trading vessels that occasionally called at the fishery. In 1864 Captain Bean, from Mackinaw Island, fished pound-nets in the vicinity for two years, these being the first in the locality, and by some claimed to be the first in Lake Superior waters. In 1866 Mr. Roach purchased other pound-nets from Lake Erie fishermen and brought them to the region, since which time this form of apparatus has been regularly employed. For some years their owner carried them to St. Mary's River and fished them there for several weeks in spring for pike and pickerel, returning to Whitefish Point late in May and fishing there until the middle of July, and again from October 1 to November 15. At present the fishing season continues throughout the summer without interruption.

Seines were used in the region in early times and fished by Indians on shares for the owners. They have been employed to a greater or less extent to the present time, though they are now only occasionally used. The first steamer engaged in the fisheries was the steamer *Addie*. In 1872 another steamer was employed, both in fishing with gill-nets and in transporting the catch of pound-nets to Point aux Pins, where it was packed for shipment. In 1876 Mr. Endress built the *Bertha Endress* and used her regularly in gill-net fishing from this locality until 1885, when she was replaced by a larger and better boat.

Statistics.—There were in 1885 twenty-three men, with seven pounds, one gill-net steamer, and one seine, employed here, the capital amounting to $25,455. The catch consisted of 576,500 pounds, valued at $23,500. This included 300,000 pounds of fresh and 89,500 pounds of salt whitefish, 148,000 pounds of fresh and 26,000 pounds of salt trout, and 13,000 pounds of herring, sturgeon, and other fish, 6,000 pounds of which were salted.

31. SAULT DE SAINTE MARIE AND VICINITY, CHIPPEWA COUNTY, MICHIGAN.

Description of the village.—Sault de Ste. Marie, a village of about 3,000 inhabitants, is situated at the extreme eastern end of Lake Superior, opposite the St. Mary's Rapids. It is the county seat of Chippewa County, surrounded by an agricultural region, with small lumber interests. Thus far it has no railroad, the nearest station being at St. Ignace, 55 miles distant. Its lack of railroad facilities is somewhat offset by the frequent opportunities for shipment by steamer to all lake points.

Indian dip-net fishing.—The region is a famous fishing-ground for the Chippewa Indians, who formerly came in considerable numbers from the interior to the vicinity of the rapids, smoking and carrying away with them the fish which they caught. During the spring and early summer large numbers of Indians were often located here and great quantities of fish were taken. As late as 1865 crude smoking and drying frames, covered with cedar strips and hung with whitefish, were not an uncommon sight along the bank of the river in the vicinity of the rapids. The dip-net fishing in the rapids by Indians is still important, and there were in 1885 about twelve canoes on the American side and six additional ones on the Canada shore. They have dip-nets about 3 feet in diameter, and canoes 18 or 20 feet long, provided with poles and paddles. One Indian sits in the stern to guide the craft, while the other stands in the bow, with a pole, by means of which he pushes the canoe well up into the rapids while looking out among the rocks and bowlders for fish. When one is seen he seizes his dip-net, with which he quickly lands it in the canoe. According to Mr. Roach, fourteen hundred whitefish, making when salted forty half-barrels of 100 pounds each, have been taken in a single day by one canoe. On May 18, 1885, the crew of one canoe dipped 1,115 pounds, worth between $40 and $50, and four days later about 5,000 pounds were landed by Indians fishing in this way. During the year 1885 the twelve crews from the American side secured about 75,000 pounds of fine whitefish. They begin dipping as soon as the ice will permit in the spring, and continue until late in November, the best fishing occurring between the middle of May and the middle of July.

Other fisheries on the American shore.—The other fishing from the village in American waters is of little importance, there being no gill-nets

fished, and no pound-nets, if we exclude Whiskey Bay and the St. Mary's River. The Indians fish extensively for herring through the ice in winter, and six crews of whites and Indians fish irregularly at Whitefish Point and Whiskey Bay, selling their catch, fresh and salt, in the village. For some years pound-nets have been set in the entrance to St. Mary's River; there were six nets in 1884, but only two were fished in 1885, both of them owned by fishermen of Detroit. Ten others were fished in St. Mary's River, and Hay and Saunders Lakes. The bulk of the catch from these pounds is sold, fresh and salt, in the village. Many of the Indians and a few whites give considerable attention to spearing herring through the ice in winter, this species taking an important place in the diet of the people during the months when they are shut off from the outside world. Eight or ten men fish occasionally with nets for herring in November and December. No fykes, trammel-nets, or seines are used in this vicinity.

Preparation of fishery products.—No fish are smoked and no caviare was prepared until 1885, when an attempt was made to utilize the spawn of the sturgeon taken on the Canadian shore, but various difficulties were met and the eggs proved to be quite small. Only about 150 pounds were put up and shipped to Cleveland. No isinglass is prepared, but the sounds of the sturgeon are now being saved by the fishermen and shipped to towns on Lake Erie.

Fisheries on Canadian shore.—Though the fisheries in American waters are so limited, the fish dealers of the village are extensively interested in fisheries along the Canadian shore. This business has already become important. It assumed considerable proportions about 1882, when fishery capitalists from Sackett's Harbor, New York, located here and purchased nets and boats, which were manned by Canadian fishermen who worked in the shore waters and bays along the Canadian shore for a distance of 50 to 75 miles. Since then others have engaged in this work, hiring their men from Georgian Bay and supplying them with nets and boats for fishing in Lake Superior waters. In 1884 pound-nets were set in several of the bays, and this fishery became quite important in 1885. The catch, which is large, is made up chiefly of sturgeon, wall-eyed pike, here called "pickerel," whitefish, and a few pickerel, locally known as "pike." Three collecting steamers, two of them belonging in Lake Erie, bring the fish from the gill-nets and pounds to the village, and two others, one of them from Detroit, together with upwards of twenty-five gill-net crews, engaged exclusively in fishing. The fish are brought to the village packed in ice and shipped chiefly to Chicago and Detroit. In 1884, according to Mr. Ainsworth, 875,000 pounds of Canadian-caught fish were handled by the dealers, and in 1885 832,000 pounds were secured, considerably over half of the catch each year being whitefish.

St. Mary's River and its fisheries.—The waters of Lake Superior find

their way to the lower lakes through the St. Mary's River, which frequently contracts into a narrow stream, and again expands into a wide sheet of water, and branches so as to include numerous islands in its passage. There are extensive fisheries in the vicinity of Detour, situated near its southern extremity, and others in the waters farther north. The first named will be treated with the fisheries of Lake Huron, but the others belong more properly to Lake Superior, and have been included with the statistics of Sault de Ste. Marie.

For nearly twenty years the pound-net fishermen of Whitefish Bay and the Sault have set their nets in these waters for pike and pickerel during the month of May, removing them later to Lake Superior. This practice is now discontinued, but ten pound-nets are fished through a greater part of the season, being shifted to different localities in Mud Lake, Lake George, and Hay Lake during the year. In addition, four crews of Indians employ gill-nets at intervals during the summer, and follow fishing with considerable regularity in the fall, selling their catch, fresh and salt, in the locality, and to the dealers at Sault de Ste. Marie.

Statistics.—The number of fishermen at the Sault de Ste. Marie and the adjoining portion of St. Mary's River in 1885 was one hundred and one, besides thirteen shoresmen and preparators. Two steamers and fifty-six sail and row boats were used in fishing; and twelve hundred and ten gill-nets and twenty-four pound-nets were employed, the total capital invested, including shore property, amounting to $53,174. The products consisted of 1,000,000 pounds of fresh and 142,000 pounds of salt fish, with a combined value of $48,110.

MAP SHOWING THE NUMBER AND LOCATION
OF THE
POUND NETS OPERATED IN
THE WATERS OF
LAKE MICHIGAN
DURING THE FISHING SEASON OF 1885
LAKE MICHIGAN
Green Bay
Washington I.
Big Pt Sable
Port Washington
Petoskey

IV.—THE FISHERIES OF LAKE MICHIGAN.

32. GENERAL REVIEW.

Physical characteristics.—Lake Michigan is the only one of the Great Lakes whose waters are wholly within the limits of the United States. It is about 345 miles long and 84 miles wide, its average depth being about 80 fathoms. Its greatest length is in a northerly and southerly direction. The shores of the southern half are very regular and uninterrupted by bays or rivers of any importance. The northern portion is more or less irregular, and has several bays of considerable size, by far the largest and most important of which is Green Bay, on the northwest. The latter is separated from the lake proper by a ridge of land, which projects from both the northern and southern ends, this being interrupted in the northern quarter, where it is broken up into a number of islands, with deep and wide passages between them, forming the entrance to the bay. The principal of these is Washington Island. The northern end of the bay is divided by a peninsula forming Big and Little Bay de Noquet. In the northeastern part of the lake, opposite Green Bay, are two bays of less importance, known respectively as Big and Little Traverse Bay, and at the extreme northeast the lake connects with Lake Huron by means of the Straits of Mackinac, thus giving free and uninterrupted navigation.

The only islands of importance are the group known as the Beaver Islands, near the northern end of the lake, the Manitou Islands, a little farther south, and the islands already mentioned, lying at the entrance of Green Bay. All of these islands lie in the northern fifth of the lake, the southern four-fifths being entirely open and containing no islands of even insignificant proportions.

Shore and population.—Along the north and northwest lie immense forests of pine, and the region contains only a scattered population, but southward along either shore the primitive forests have been cut away to a greater or less extent, and a considerable percentage of the clearings devoted to agricultural purposes. The population is here considerably larger in proportion to the area, and large saw-mills occur at the mouth of nearly every river to utilize the logs, which after being rafted down the streams are cut up and distributed to different points on the southern end of the lake by means of the large merchant fleet, which finds employment in this way during at least eight months of the year.

Continuing southward, the shores, which are more or less sandy

throughout, gradually change into beaches of pure sand, the barren belt often extending several miles inland before soil suitable for agricultural purposes is found; both the agricultural and commercial interests become more extensive, and the population of many of the towns is largely interested in manufactures. The eastern shore contains the famous fruit belt of Michigan, and a large acreage is devoted to orchards, whose products find a ready sale in the larger cities.

Traces of the Indians are still abundant at the northern end of the lake, where numerous half-breeds of Indian and French-Canadian blood are found. Along the entire northern half of the lake, and even further south, the Swedes, Norwegians, Danes, Germans, and emigrants from other European countries have gathered in large numbers. Along the southern end there is also a large foreign element, though the native-born Americans form a very much larger percentage.

The principal cities and, in fact, the only ones of any considerable commercial importance are Chicago, near the southern end of the lake, and Milwaukee, 85 miles to the northward, on its western shore. Numerous smaller cities, varying from 5,000 to 15,000 inhabitants, occur at intervals in different portions of the lake. The principal business in the northern half, as already mentioned, is lumbering, which furnishes employment to a majority of the population, while in the southern half the fruit-growing, agricultural, and manufacturing interests predominate.

Location of the fisheries.—The fisheries are not confined to any one locality, but are scattered throughout the entire lake, the most important interest at present centering along the north shore, in the vicinity of the Beaver Islands and in Green Bay, though in other localities, both along the east and west shores, a large amount of capital is employed in this industry. The early fisheries were carried on principally from the southern and western shores of the lake, though fishermen from the lower lakes located temporarily at other points and made large catches of whitefish, which they salted and shipped to the fishery centers of Lake Erie.

Fishermen.—The business was formerly prosecuted by American fishermen and by the Indians, but as the country has gradually filled up with foreigners many of these have engaged in fishing, and the industry is now practically in their hands, the Germans, Scandinavians, Irish, and French Canadians predominating. The few remaining Americans are men who became interested in the work at an early date, or members of their families who have grown up in the business.

Pound-net fisheries.—The first pound-net in the lake was set in 1856 or 1857. In 1858 apparatus of this kind was introduced at Menominee, Michigan, and Little Suamico, Wisconsin, both on the western shore of Green Bay. The next year it appeared in Whitefish Bay, Door County, Michigan, in the Big Bay de Noquet, and at the Beaver Islands. It then spread rapidly to all parts of the lake, and was soon

fished very extensively, especially along the western and the northern shores. At the present time there is nowhere a strip of coast 50 miles in extent where it is not in use. The center of the pound-net fishery has been for years in Green Bay, though in the southern portion of these waters the quantities of whitefish have been very much reduced, and the nets are now employed in the capture of herring and other species. The most important pound-net fisheries for whitefish in 1885 were along the northern shores of the lake and about the Beaver Islands.

Importance of the gill-net fisheries.—Gill-nets are more extensively employed in Lake Michigan than in any of the other lakes of the chain. At first only a few were owned by each fisherman, these being set from sail-boats near the land, but gradually the quantity of netting has been increased, steamers have been gradually replacing the sail-boats at the principal fishery centers, and the nets have been set farther and farther from shore, until now the ends of those belonging to fishermen of opposite sides nearly meet at the center.

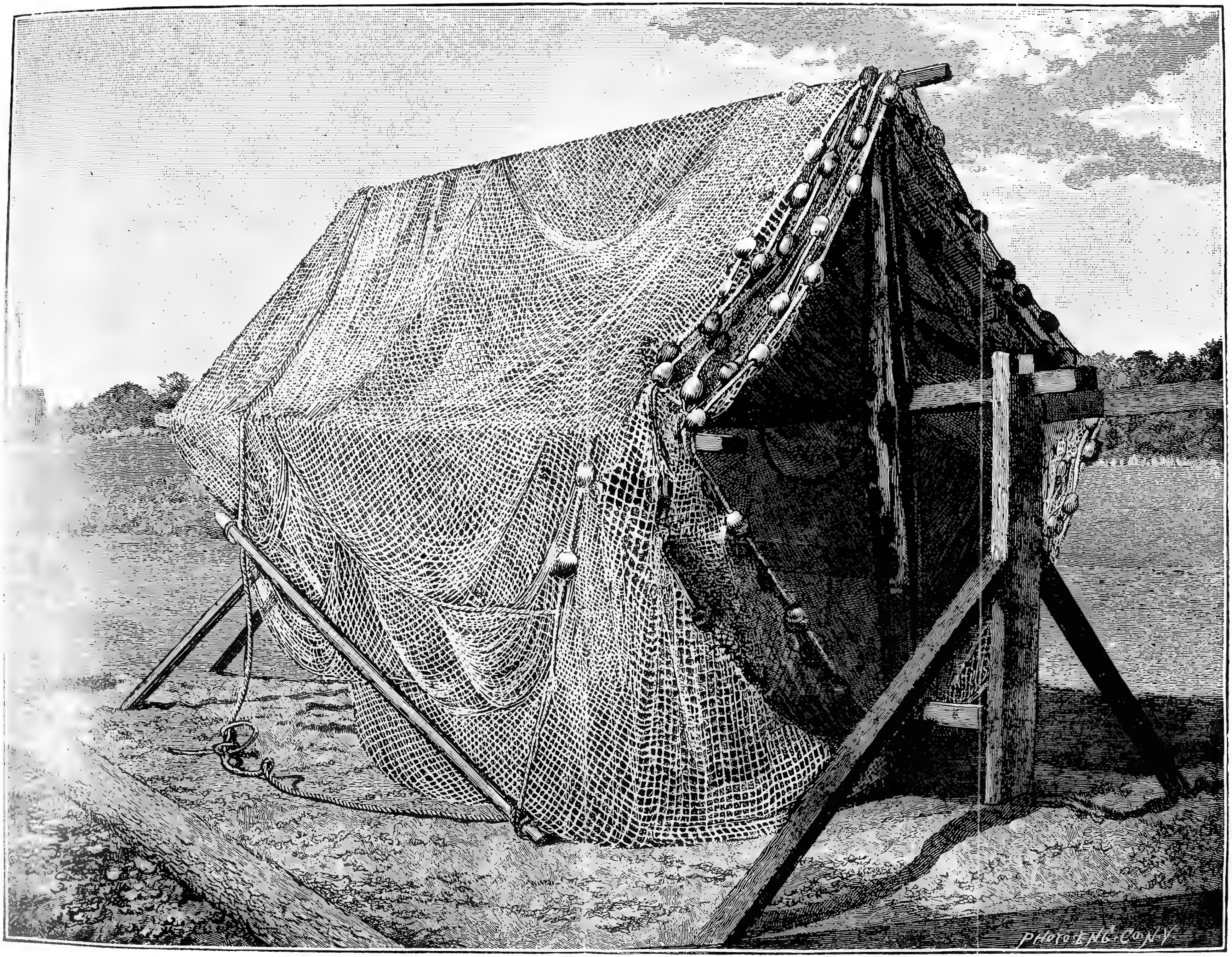
Mode of setting gill-nets.—Where the bottom of the lake is very irregular, and the ridges have abruptly sloping sides, frequent use of the lead-line is required in setting the nets, and soundings are taken at intervals of five to fifteen minutes. In this way the captain is enabled to follow the ridges, keeping the nets in a certain depth of water, which varies with the season and the locality. On grounds of this nature the set is very irregular, following closely the direction of the ridge, usually a few fathoms from the top, where the fish are feeding in greater numbers than on the top of the ridge or in the valley. A fisherman well acquainted with the grounds thus has a decided advantage over one not possessing similar technical knowledge, and it frequently happens that, other things being equal, the former will catch from a third more to fully double the quantity obtained by his rival. In other localities, where the bottom is level, the nets are usually set in a straight line at right angles to the current, which is usually parallel with the shore, the depth varying with the season from 5 to 70 fathoms, and the distance from shore often reaching 25 and 30 miles. The nets are most frequently set on the bottom of the lake, but in some places it is customary at certain seasons, to put them near the surface, the vertical position varying according to the habits of the fish.

Mode of hauling cork and lead gill-nets from steamers.—Six men are usually required for steamer fishing. When lifting the nets the captain stands at the wheel in the pilot-house and the engineer remains constantly at his engine. Two men are engaged in hauling the nets, walking backwards diagonally across the deck from the net-roller to near the pilot-house, one going forward to get a fresh hold while the other is going back. The two remaining fishermen stand on a slightly elevated platform at the hatch, one removing the fish while the other runs the wet nets into boxes. The steamer is kept under a slight head-

way in the direction in which the nets are laid during the hauling to make the work easier, or, frequently, it is started forward for a short distance, after which the engine is stopped until the fishermen have gathered in the slack, when the operation is repeated. After the lifting of eight nets, which usually consumes from fifteen to forty minutes, according to the depth of water, the fishermen relieve each other, those removing the fish and stowing the net coming on deck to begin hauling the next nets, while the others take the places vacated by them in the hold.

Mode of reeling gill-nets.—As soon as the fish have been properly iced all hands, including the shoresmen, turn their attention to spreading or reeling nets. The reel is a wooden frame, about 10 feet long and 5 to 6 feet square. It is composed of three pairs of wooden arms, nailed at right angles to each other, one at either end and the other at the middle of a central axis, which revolves upon two wooden uprights. To the outer ends of these arms are nailed 6-inch boards, extending lengthwise of the reel. The boxes containing the wet nets, usually four in a box, are brought from the tug to the reel-yard, the ends of the nets are secured to one of the arms of the reel, and the net, which varies from 5 to 6 feet in breadth, is spread out upon it as the reel is revolved, the lines being advanced slightly towards the opposite end of the reel at each turn. One reel in this way serves for about eight nets, during the spreading of which, requiring from thirty-five to forty-five minutes, it makes about ninety complete revolutions. The nets are allowed to remain until thoroughly dry, when they are removed by the shoresmen, one of whom places the floats in rows along one end of the net-box while the other carefully arranges the leads at the other end, the netting forming a bunch in the center. Eight of these dry nets are stowed into a box nearly twice the size of the one for wet nets. Rapid workers will box a reel of eight nets in fifteen to twenty minutes. When boxed the nets are set aside until the steamer arrives, and the boxing must be completed by this time in order to make room for the new stock of wet nets.

Mode of cleaning gill-nets.—If gill-nets are to be kept in proper condition for any extended period the greatest care must be taken for their preservation. It is a common practice among fishermen to wash them frequently; some of the sail-boat netters wash their nets as often as once a week, and boil them in hot water containing soap and tanbark at frequent intervals. The tug fishermen have a decided advantage in having steam constantly available for boiling the nets. They usually remove the corks about once a month, and on their way from the fishing-grounds slacken the speed of the tug and pay out a bight of 6 to 15 fathoms of netting from the stern of the steamer, dragging it slowly through the water, a fisherman hauling in on one side of the bight as fast as the netting is paid out on the other. This process removes the greater part of the dirt and slime which may have accumu-



GILL-NET DRYING ON REEL. (See page 74.)

From a photograph

lated; but about once in six weeks to two months they find it desirable to boil the nets. They usually have large wooden tanks expressly for this purpose. These are filled with cold water and about five or six bars of soap are added, after which the nets are immersed and the steam-pipe from the bottom is connected with the boiler of the tug and the nets allowed to boil for half an hour, after which they are taken out and spread upon the reels to dry.

Mode of oiling floats for gill-nets.—Many of the older fishermen who are accustomed to the float and stone rig object to using the more modern lead and cork, claiming that they have great difficulty in keeping the cork floats from water-logging and consequent sinking of the nets to the bottom. These continue to use the cumbersome wooden floats and stone sinkers, even though more labor is required in handling and the crew cannot fish as many nets. Some fishermen, however, have discarded the float and stone, and use exclusively the cork and lead. The corks are turned out of cedar or poplar, and have a hole through the center, like a bead, through which the seaming twine is passed when the float is secured to the meter. Great care is required in oiling these floats, and unless properly done trouble is constantly experienced by their getting water-logged.

The float to be properly oiled should be first thoroughly dried and then immersed in cold linseed-oil (boiled) and allowed to remain for from twenty-four to forty-eight hours or until it has become thoroughly saturated. It should then be dipped in hot linseed-oil containing about 5 pounds of rosin, a little japan, and a little bees-wax for each gallon of oil. After being removed it should again be put in a dry place and allowed to remain one or two months. This makes the float practically impervious to water, as the first coat of oil has hardened in the interior and the second forms a nearly water-proof coating on the outside. Some give the floats a third bath before they are used, but most fishermen consider two sufficient. Even with this protection a duplicate set of corks is required to replace the others, which should be fished only half of the season before being removed for the annual oiling, which they should always receive. If the floats are used before the oil in the interior has become thoroughly hardened the pressure of the water at any considerable depth will drive all of the liquid oil out through the pores of the wood, and the float will become heavy and fail to suspend the net. Fully as serious a trouble experienced from water-logged floats is that in warm weather the moisture from them is liable to rot the nets when they are left boxed for any length of time.

The blackfin fishery.—Most of the gill-net fishing is for trout and whitefish. A fishery peculiar to this lake is that for the blackfin variety of whitefish (*Coregonus nigripinnis*). Steamers and sail-boats from Manistee and Ludington, and occasionally from Frankfort, engage in the capture of blackfins for a greater or less period every year. The fishing is in water of from 60 to 80 fathoms. Some of the fishermen

set in this depth only a few times during the season, but others, engaging exclusively in the capture of blackfins for several months, set their nets regularly in deep water. Those thus fishing begin about the 1st of November, when the fish make their appearance in limited quantities, the number increasing until December, when the business is at its height, the catch throughout the entire month, when the weather will permit, being very large. By this time the ice prevents further operations, but as soon as it breaks up in spring, frequently the last of February or early in March, they again visit the blackfin grounds and continue fishing until the middle or last of May, in some instances following the fish as they work off into deeper water until 100 or even 110 fathoms is reached. This seems to be a limit of depth for the nets, as the floats are considerably distorted by the enormous pressure of the water and soon become water-logged. Large lifts are occasionally made by those fishing for blackfins. Thomas Rudick & Co., of the fishing-tug *John Smith*, of Manistee, report a catch of 4,000 pounds out of one lift of thirty nets in the fall of 1884, among these being individual fish weighing 4 and even 5 pounds, the average weight being between 2 and 3 pounds. Among them are fish of similar shape, but without the dark coloring on the fins. These the fishermen style "long jaws." They are usually mixed with the others and sold at the same price, but some consider them of little value, and, occasionally, throw them away.

The meshes of the nets used in this fishery vary from 3½ to 4½ inches. One fisherman used nothing smaller than 4⅛ inches, which was very satisfactory.

In December and January the blackfins gather upon stony bottom to deposit their eggs, but they seem to prefer clay at other seasons of the year.

The average sail-boat now carries from sixty to a hundred nets, while several times that quantity are fished by the steamers. Steamers were first employed for fishing in this lake in 1869, the first vessels being the *Kittie Gaylord*, of Washington Island, and the *Pottawattomie*, owned near Green Bay, though a year or two earlier a fisherman from Kenosha put a small engine in his boat, which he used in running back and forth from the fishing-grounds. There were in 1885 seventy fishing and twelve collecting steamers used on Lake Michigan, the principal centers being at Milwaukee, Cheboygan, Manistique, Frankfort, Grand Haven, and St. Joseph.

Set-lines.—These have never been extensively employed in the northern end of the lake; but are used in large numbers in the southern section, where they are in high favor. Set-lines were formerly used for catching sturgeon at Milwaukee, and are still employed principally for this species at the fishing settlements along the eastern shore. They are also set in great numbers for the capture of trout, and occasionally for whitefish. Several years ago some of the fishermen at Racine and

Milwaukee who had come from the Baltic Sea, where they had been accustomed to use set-lines for salmon, began setting them for trout midway between the bottom and the surface of the water. This method was soon adopted by the other fishermen, and is now extensively practiced during the summer months, when, owing to the high temperature of the water, the fishermen do not care to keep a large number of nets in the lake.

Fyke-nets.—Fyke fishing is confined largely to the waters at the southern end of Green Bay, in the vicinity of the city of that name, where they are fished extensively in the shoal waters and along the borders of the marshy flats. They are used to a small extent in other localities, but not in sufficient numbers to render the fishery important.

Trammel-nets.—Trammel-nets or pocket-nets are unknown to the majority of the fishermen, though a few foreigners, who have used them in European waters, set a small number in the mouths of rivers. They are here generally known as "plunk-nets" or "plump-nets," from the noise occasioned by the stick or splasher employed to frighten the fish into them.

Ice fishing.—There is no fishing through the ice in the southern end of the lake, but in the northern end, especially in Green Bay and along the north shore, this fishery is extensive. For twenty years it has furnished employment to a very large number of men living in the vicinity of Green Bay, and many fishermen from other localities have found employment here during the winter months. During certain seasons the bay presented greater activity than the surrounding land, hundreds of shanties and temporary huts being built for shelter, the fishermen living in them during a greater portion of the time. Dealers drove about from place to place on the ice to purchase the catch, and merchants sent supply wagons to furnish the fishermen with provisions. During the height of the season it was not uncommon for the fishermen to bring their families out to the fishing quarters, where they would remain for some weeks, all hands assisting in keeping the nets in repair. During the past four or five years this fishery, owing to the diminution in the quantity of whitefish, has been less extensive, and the fishermen engaged in it at present generally live at home, owning a horse and sleigh, which enables them to visit their nets daily and bring their catch to land.

Near the entrance to Green Bay and along the north shore on either side of the lake there is frequently considerable spearing and spring-line fishing through the ice for trout. The methods of spearing are similar to those employed by the fishermen of Lake Superior. The spring-line fishing is also similar to that of Lake Superior, but less extensive.

Varieties and relative importance of fish.—The principal species taken, as would be inferred from the foregoing, are whitefish and trout in about equal quantities, wall-eyed pike, sturgeon, and herring. The sis-

cowet or deep-water variety of the trout occurs throughout the northern portion of the lake, and especially between the Manitou and Beaver Islands. In some places fully half of the trout taken are of this kind. Messrs. Jordan & Gilbert, in their Synopsis of the Fishes of North America, published in 1882, stated (page 318) that the siscowet was then abundant in Lake Superior, but not yet found elsewhere.

In localities convenient to a market the fishermen realize nearly as much per pound for their sturgeon as for any other species; but in places more remote, especially in the northern end of the lake, many of the sturgeon are thrown away, owing to the difficulty which the fishermen experience in disposing of them.

Fishing season.—The fishing begins early in May and continues with slight interruptions until late in November, though in most localities the operations are less extensive in midsummer. A few of the fishermen, as already mentioned, engage in the winter ice fishery, but this is not followed regularly, except in Green Bay.

Markets.—Chicago practically controls the entire catch of Lake Michigan, and the leading dealers have arrangements with lake steamers or railroads whereby the catch is forwarded with all possible dispatch. One firm has built two steamers which are employed regularly in collecting and marketing the fish. These are among the swiftest vessels on the lake, and are kept constantly busy during the fishing season. Fully three-quarters of the entire catch is marketed fresh, as, owing to the lower prices of salt fish, no fisherman will salt his catch when he can make other disposition of it; and it is only at remote stations that any considerable percentage of the catch is salted.

Freezing of fish.—At Escanaba, Fairport, Sturgeon Bay, Petoskey, and Traverse City, all situated at the northern end of the lake, refrigerators have been built for freezing and retaining any surplus of fish caught during summer until winter, when the demand for them at a higher price warrants their shipment. The largest freezing establishment is at Escanaba, which takes the surplus catch from Bay de Noquet and the leading fisheries along the north shore, including occasional quantities from the Beaver Islands.

Smoking of fish.—The smoking of fish by fishermen is less extensive now than formerly, when in many localities a considerable percentage of small fish was smoked and packed in boxes for shipment. A few fishermen still continue this practice, but the smoked-fish trade is in large part supplied by persons located at the principal markets, who buy at a low figure any surplus fish which the trade find difficulty in handling, and cart them off to be smoked and packed in boxes for distribution to the retail trade and to peddlers. Sturgeon is the favorite species for smoking, though small whitefish, herring, and even trout are used.

Prices.—The price varies considerably with the season and with the difficulties and cost of transportation. In the more remote regions the

fishermen receive an average of only 2 or 3 cents a pound for their whitefish and trout, while in others 4 or even 5 cents is readily obtained. During a few months in the fall, when the large trout are abundant, the price frequently drops, so that the fishermen receive almost nothing for this species, and are frequently obliged to stop fishing until the surplus stock in the market has been worked off. At this season trout of large size are taken in quantities, and the dealers find great difficulty in getting rid of them. They are therefore often compelled to require the fishermen to cull the trout, those under 7 pounds in weight being classed as small fish, while those of greater size are known to the trade as large fish and meet with a very limited demand.

Statistics.—The following tables show the details of the fisheries in 1885 for each section bordering on Lake Michigan:

Table of persons employed in the fisheries of Lake Michigan in 1885.

Section.	Fishermen.		Shoresmen, preparators, and mechanics.	Total.	Persons dependent on the foregoing.
	Professional.	Semi-professional.			
The North Shore, Michigan	168	10	5	183	403
Manistique and Thompson, Michigan	26	....	27	53	84
Point aux Barques to Point Detour, Michigan	30	....	....	30	55
Bay de Noquet, Michigan	101	4	11	116	300
Escanaba and vicinity, Michigan	51	33	9	93	228
Menominee County, Michigan	48	2	6	56	101
Marinette County, Wisconsin	49	5	2	56	115
Oconto County, Wisconsin	68	42	....	110	147
Suamico to Green Bay City, Wisconsin	25	58	30	113	206
Bay Settlement to Namur, Wisconsin	16	143	....	159	191
Little Sturgeon and vicinity, Wisconsin	27	60	....	87	141
Sturgeon Bay and Canal, Wisconsin	46	....	8	54	146
Entrance of Sturgeon Bay to Death's Door, Wisconsin	81	66	1	148	310
Washington Island, Door County, Wisconsin	20	8	....	28	98
Newport to Lily Bay, Wisconsin	33	....	....	33	100
Horn's Pier to Nero, Wisconsin	44	21	4	69	157
Manitowoc County, Wisconsin	61	6	3	70	210
Sheboygan County, Wisconsin	63	4	5	72	170
Ozaukee County, Wisconsin	4	7	....	11	20
Milwaukee County, Wisconsin	84	10	51	145	518
Racine, Wisconsin	21	2	2	25	50
Kenosha, Wisconsin	20	8	8	36	90
Waukegan, Illinois	13	....	....	13	30
Chicago and South Chicago, Illinois	30	363	60	453	720
Indiana	41	24	1	66	175
Berrien and Van Buren Counties, Michigan	90	41	5	136	290
Allegan County, Michigan	26	31	....	57	125
Grand Haven, Michigan	31	12	13	56	121
Muskegon and Montague, Michigan	54	26	1	81	202
Oceana County, Michigan	28	2	....	30	60
Mason and Manistee Counties, Michigan	44	16	3	63	124
Frankfort and South Frankfort, Michigan	47	....	9	56	61
Aral to Good Harbor, Michigan	19	6	1	26	39
Grand Traverse Bay and vicinity, Michigan	136	51	6	193	310
Charlevoix, Michigan	37	12	8	57	110
Little Traverse Bay, Michigan	22	8	11	41	91
Cross Village and Good Hart, Michigan	40	4	2	46	104
Mackinaw City to Point Waugoshance, Michigan	6	32	3	41	78
Beaver, Fox, and Manitou Islands, Michigan	164	23	30	217	529
Total	1,914	1,140	325	3,379	7,009

Table of apparatus and capital employed in the fisheries of Lake Michigan in 1885.

Section.	Steamers.				Sail and row boats.						
	Fishing.		Collecting fish.		Gill-net boats.	Pound-net boats.	Sail-boats collecting fish.	Seine-boats.	Other boats.	Total.	
	No.	Value.	No.	Value.	No.	No.	No.	No.	No.	No.	Value.
The North Shore, Michigan	...	...	2	$4,000	55	33	...	3	48	139	$11,635
Manistique and Thompson, Michigan	3	$10,300	2	15,000	1	3	...	...	3	7	555
Point aux Barques to Point Detour, Michigan	...	...	...	...	14	...	...	...	...	14	1,870
Bay de Noquet, Michigan	3	6,500	1	6,500	20	17	2	...	13	52	10,325
Escanaba and vicinity, Michigan	...	...	1	8,000	6	8	...	...	16	30	3,021
Menominee County, Michigan	...	...	1	2,000	...	19	...	...	23	42	3,440
Marinette County, Wisconsin	...	...	...	...	9	6	...	...	10	25	2,070
Oconto County, Wisconsin	...	...	...	...	...	27	...	...	29	56	2,319
Suamico to Green Bay City, Wisconsin	...	...	4	11,000	...	8	...	4	32	44	1,240
Bay Settlement to Namur, Wisconsin	...	...	...	...	...	7	...	12	5	24	475
Little Sturgeon and vicinity, Wisconsin	...	...	...	...	9	8	...	...	1	18	595
Sturgeon Bay and Canal, Wisconsin	2	3,000	...	...	7	4	...	...	1	12	865
Entrance of Sturgeon Bay to Death's Door, Wisconsin	1	1,500	...	...	30	11	...	...	2	43	2,650
Washington Island, Door County, Wisconsin	...	...	...	...	17	1	...	...	...	18	2,050
Newport to Lily Bay, Wisconsin	...	...	...	...	13	7	...	...	...	20	1,230
Horn's Pier to Nero, Wisconsin	1	2,500	...	...	23	1	...	2	8	34	1,993
Manitowoc County, Wisconsin	...	...	...	...	21	12	...	...	10	43	2,850
Sheboygan County, Wisconsin	5	19,200	...	...	9	27	...	...	15	51	4,900
Ozaukee County, Wisconsin	...	...	...	...	...	6	...	1	...	7	335
Milwaukee County, Wisconsin	7	20,500	...	...	7	2	...	...	12	21	1,595
Racine, Wisconsin	2	7,400	...	...	3	...	...	1	2	6	805
Kenosha, Wisconsin	3	9,100	...	...	...	...	...	3	...	3	42
Waukegan, Illinois	...	...	...	...	...	5	...	...	11	16	525
Chicago and South Chicago, Illinois	2	16,000	...	...	6	5	...	2	29	42	2,695
Indiana	4	8,500	...	...	7	9	...	2	23	41	3,105
Berrien and Van Buren Counties, Michigan	10	39,000	...	...	10	15	...	2	28	55	4,592
Allegan County, Michigan	6	15,000	...	...	7	6	...	1	18	32	1,810
Grand Haven, Michigan	4	11,200	...	...	3	8	...	...	16	27	1,030
Muskegon and Montague, Michigan	5	11,500	...	...	15	11	...	4	39	69	2,844
Oceana County, Michigan	1	1,400	...	...	4	13	...	2	6	25	2,645
Mason and Manistee Counties, Michigan	3	4,700	...	...	22	5	...	3	3	33	1,980
Frankfort and South Frankfort, Michigan	2	7,000	...	...	11	7	...	2	8	28	1,640
Aral to Good Harbor, Michigan	...	...	...	...	6	8	...	...	1	15	487
Grand Traverse Bay and vicinity, Michigan	...	...	...	...	54	7	2	2	15	80	5,310
Charlevoix, Michigan	4	12,100	...	...	11	...	...	...	3	14	1,265
Little Traverse Bay	...	...	1	4,200	10	7	...	...	1	18	825
Cross Village and Good Hart, Michigan	...	...	...	...	17	4	...	...	5	26	1,550
Mackinaw City to Point Waugoshance, Michigan	...	...	...	...	2	1	1	1	...	5	246
Beaver, Fox, and Manitou Islands, Michigan	2	10,500	...	...	...	34	3	2	46	85	11,317
Total	70	216,900	12	50,700	429	352	8	49	482	1,320	100,726

Table of apparatus and capital employed in the fisheries of Lake Michigan in 1885—Cont'd.

Section.	Apparatus of capture.					
	Gill-nets.			Haul-seines.		
	No.	Length.	Value.	No.	Length.	Value.
		Feet.			*Feet.*	
The North Shore, Michigan	5,580	1,513,350	$30,492	3	16,200	$225
Manistique and Thompson, Michigan	530	461,700	9,540			
Point aux Barques to Point Detour, Michigan	1,400	378,000	8,050			
Bay de Noquet, Michigan	3,240	813,600	14,625	1	1,000	100
Escanaba and vicinity, Michigan	935	252,450	4,700	9	4,500	1,500
Menominee County, Michigan	215	20,640	1,100			
Marinette County, Wisconsin	866	114,780	3,410	2	1,560	400
Oconto County, Wisconsin	745	196,140	3,405	2	2,475	70
Suamico to Green Bay City, Wisconsin	260	12,000	1,285	7	1,000	390
Bay Settlement to Namur, Wisconsin	2,945	125,160	15,700	11	10,900	1,530
Little Sturgeon and vicinity, Wisconsin	1,736	416,640	8,755			
Sturgeon Bay and Canal, Wisconsin	1,227	346,000	6,267			
Entrance of Sturgeon Bay to Death's Door, Wisconsin	1,253	401,760	8,037			
Washington Island, Door County, Wisconsin	1,100	297,000	5,200			
Newport to Lily Bay, Wisconsin	867	234,090	4,335			
Horn's Pier to Nero, Wisconsin	1,597	431,190	7,995	2	200	30
Manitowoc County, Wisconsin	1,838	585,960	12,850	2	660	60
Sheboygan County, Wisconsin	2,028	608,400	12,800			
Ozaukee County, Wisconsin	106	28,620	515	1	100	20
Milwaukee County, Wisconsin	4,876	1,169,040	21,340	12	1,600	250
Racine, Wisconsin	728	212,380	4,043	1	300	40
Kenosha, Wisconsin	1,540	314,000	8,470	3	1,620	180
Waukegan, Illinois						
Chicago and South Chicago, Illinois	542	140,675	3,788	2	500	50
Indiana	779	259,950	4,817	3	1,980	210
Berrien and Van Buren Counties, Michigan	3,250	774,130	15,989	3	1,686	180
Allegan County, Michigan	1,257	276,839	5,638	1	1,320	100
Grand Haven, Michigan	1,921	398,450	9,222			
Muskegon and Montague, Michigan	1,489	363,005	5,547	7	2,318	320
Oceana County, Michigan	254	50,800	948	2	1,615	160
Mason and Manistee Counties, Michigan	2,003	559,400	13,410	5	2,060	370
Frankfort and South Frankfort, Michigan	2,102	571,860	14,105	1	200	40
Aral to Good Harbor, Michigan	110	26,400	350			
Grand Traverse Bay and vicinity, Michigan	2,011	542,900	11,663	2	600	200
Charlevoix, Michigan	2,826	606,900	18,369			
Little Traverse Bay, Michigan	121	32,670	665			
Cross Village and Good Hart, Michigan	320	88,400	1,600			
Mackinaw City to Point Waugoshance, Michigan	25	4,125	63	1	165	25
Beaver, Fox, and Manitou Islands, Michigan	3,894	1,290,560	27,814	4	1,980	500
Total	58,516	14,919,964	326,902	87	56,539	6,950

Table of apparatus and capital employed in the fisheries of Lake Michigan in 1885—Cont'd.

Section.	Apparatus of capture—Continued.										
	Traps.						Set-lines.			Value of spears, hand-lines, dip-nets, and trammel-nets.	Total value of apparatus of capture.
	Pound-nets.		Fyke-nets.		Other traps.		Length.	No. of hooks.	Value.		
	No.	Value.	No.	Value.	No.	Value.					
							Feet.				
The North Shore, Mich	68	$27,275								$300	$58,292
Manistique and Thompson, Michigan	11	3,500									13,040
Point aux Barques to Point Detour, Michigan							4,000	500	$88		8,138
Bay de Noquet, Michigan	44	21,000	18	$390						30	36,145
Escanaba and vicinity, Michigan	37	10,600	3	180						50	17,030
Menominee County, Mich	42	13,900									15,000
Marinette County, Wis	14	3,800	3	75							7,685
Oconto County, Wisconsin	79	10,800	28	500							14,775
Suamico to Green Bay City, Wisconsin	7	660	215	3,583			54,000	6,000	150		6,068
Bay Settlement to Namur, Wisconsin	12	2,625	20	200			8,000	900	18		20,073
Little Sturgeon and vicinity, Wisconsin	20	5,900	18	350							15,005
Sturgeon Bay and Canal, Wisconsin	10	2,080	1	20							8,367
Entrance of Sturgeon Bay to Death's Door, Wis	17	6,200	10	172			18,000	2,000	50	175	14,734
Washington Island, Door, County, Wisconsin	2	500								20	5,720
Newport to Lily Bay, Wis	4	1,600									5,935
Horn's Pier to Nero, Wisconsin	2	450								100	8,575
Manitowoc County, Wisconsin	20	7,300	3	43			80,000	10,000	137	10	20,400
Sheboygan County, Wis	38	19,600					32,800	4,100	55	15	32,470
Ozaukee County, Wis	4	2,800					25,000	3,000	20	10	3,365
Milwaukee County, Wis	2	800	10	150	1,500	$30	168,000	21,000	240	190	23,000
Racine, Wisconsin							450,000	25,000	500	60	4,643
Kenosha, Wisconsin			6	30			31,500	4,500	70	30	8,780
Waukegan, Illinois	13	6,500									6,500
Chicago and South Chicago, Illinois	10	4,600	1	35			234,000	23,400	200	500	9,173
Indiana	29	17,600					250,000	30,000	317		22,944
Berrien and Van Buren Counties, Michigan	35	14,150	1	10			1,033,000	102,800	1,188		31,517
Allegan County, Michigan	11	2,700	2	20			1,787,500	168,000	1,135		9,593
Grand Haven, Michigan	13	4,070	1	10			320,000	32,000	159		13,461
Muskegon and Montague, Michigan	39	8,325	13	132	1	100	825,000	90,200	655		15,079
Oceana County, Michigan	26	7,415					80,000	8,500	95		8,618
Mason and Manistee Counties, Michigan	8	1,650	4	40			91,700	12,100	105		15,575
Frankfort and South Frankfort, Michigan	7	2,800									16,945
Aral to Good Harbor, Michigan	14	2,300									2,650
Grand Traverse Bay and vicinity, Michigan	12	2,500	5	165						80	14,608
Charlevoix, Michigan					4	200	90,000	15,000	200	100	18,869
Little Traverse Bay, Mich	13	7,700								105	8,470
Cross Village and Good Hart, Michigan	12	5,890									7,490
Mackinaw City to Point Waugoshance, Mich	3	300								135	523
Beaver, Fox, and Manitou Islands, Michigan	52	23,550					13,500	1,500	30		51,894
Total	710	253,540	362	6,105	1,505	330	5,596,000	569,400	5,412	1,910	601,149

Table of apparatus and capital employed in the fisheries of Lake Michigan in 1885—Cont'd.

Section.	Shore property.					Total capital invested.
	Value of buildings and wharves.	Value of fixtures and accessories.	Fish-cars.		Working capital.	
			No.	Value.		
The North Shore, Michigan	$4,600	$3,448			$1,850	$83,825
Manistique and Thompson, Michigan	6,500	1,300	130	$3,450	6,500	56,645
Point aux Barques to Point Detour, Michigan	700	210			150	11,068
Bay de Noquet, Michigan	21,500	4,350			23,000	108,320
Escanaba and vicinity, Michigan	16,250	3,460			25,000	72,761
Menominee County, Michigan	3,275	3,075			8,100	34,890
Marinette County, Wisconsin	1,200	680	30	600	5,000	17,235
Oconto County, Wisconsin	7,405	3,510				28,009
Suamico to Green Bay City, Wisconsin	4,225	5,860			15,200	43,593
Bay Settlement to Namur, Wisconsin	2,395	2,100				25,043
Little Sturgeon and vicinity, Wisconsin	2,070	590				18,260
Sturgeon Bay and Canal, Wisconsin	8,955	1,470	5	30	1,000	23,687
Entrance of Sturgeon Bay to Death's Door, Wis.	1,600	1,445			500	22,429
Washington Island, Door County, Wisconsin	100	110				7,980
Newport to Lily Bay, Wisconsin	935	274				8,374
Horn's Pier to Nero, Wisconsin	12,135	1,475			3,000	29,678
Manitowoc County, Wisconsin	2,830	900			2,000	28,980
Sheboygan County, Wisconsin	18,600	6,500			3,525	85,195
Ozaukee County, Wisconsin	300	120				4,120
Milwaukee County, Wisconsin	33,800	9,000			17,000	104,895
Racine, Wisconsin	5,000	1,200			400	19,448
Kenosha, Wisconsin	4,000	1,000			1,000	23,922
Waukegan, Illinois	1,300	40				8,365
Chicago and South Chicago, Illinois	190,000	10,600	300	9,000	100,000	337,468
Indiana	7,275	1,800			4,900	48,524
Berrien and Van Buren Counties, Michigan	11,600	3,520			4,250	94,479
Allegan County, Michigan	2,165	1,700			600	30,868
Grand Haven, Michigan	1,015	665			700	28,071
Muskegon and Montague, Michigan	1,160	1,417				32,000
Oceana County, Michigan	1,110	500	29	375	150	14,798
Mason and Manistee Counties, Michigan	3,045	365	10	75	100	25,840
Frankfort and South Frankfort, Michigan	10,475	1,950	63	1,540	2,200	41,750
Aral to Good Harbor, Michigan	815	640				4,592
Grand Traverse Bay and vicinity, Michigan	8,030	1,176			800	29,924
Charlevoix, Michigan	2,100	900			800	36,034
Little Traverse Bay, Michigan	4,500	1,675	28	840	5,100	25,610
Cross Village and Good Hart, Michigan	1,025	770			300	11,135
Mackinaw City to Point Waugoshance, Michigan	430	441	5	50	1,000	2,690
Beaver, Fox, and Manitou Islands, Michigan	20,770	6,950	150	4,800	21,095	127,326
Total	425,190	87,186	750	20,760	255,220	1,757,831

Table of products of the fisheries of Lake Michigan in 1885.

Section.	Sold fresh.						
	White-fish.	Trout.	Sturgeon.	Herring.	Pike and pickerel.	Miscellaneous.	Total.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
The North Shore, Michigan	548, 686	135, 444	10, 000	4, 720		12, 530	711, 380
Manistique and Thompson, Michigan	392, 219	512, 907	4, 000			1, 350	910, 476
Point aux Barques to Point Detour, Michigan	19, 500	6, 500					26, 000
Bay de Noquet, Michigan	265, 278	262, 563	99, 192	29, 715	15, 731	15, 000	687, 479
Escanaba and vicinity, Michigan	170, 514	29, 563	24, 588	88, 066	60, 000	28, 763	401, 494
Menominee County, Michigan	21, 500	7, 000	7, 209	21, 900	5, 200	1, 000	63, 809
Marinette County, Wisconsin	77, 500	7, 500	50, 000	220, 000	27, 000	7, 000	389, 000
Oconto County, Wisconsin	33, 430	17, 800	27, 505	576, 000	70, 704	175, 000	900, 439
Suamico to Green Bay City, Wisconsin			2, 200	310, 000	365, 000	893, 200	1, 570, 400
Bay Settlement to Namur, Wisconsin	147, 000	33, 445	58, 450	13, 570	92, 725	168, 775	513, 965
Little Sturgeon and vicinity, Wisconsin	191, 400	40, 425	23, 125	61, 030	3, 825	44, 750	364, 555
Sturgeon Bay and Canal, Wisconsin	153, 060	60, 125	6, 900	40, 560	1, 500	4, 500	266, 645
Entrance of Sturgeon Bay to Death's Door, Wisconsin	185, 440	115, 770	3, 000	33, 925		6, 650	344, 785
Washington Island, Door County, Wisconsin	15, 400	8, 000					26, 400
Newport to Lily Bay, Wisconsin	11, 200	65, 250	250	27, 000		2, 000	105, 700
Horn's Pier to Nero, Wisconsin	1, 000	433, 900		1, 200		17, 400	453, 500
Manitowoc County, Wisconsin	30, 200	240, 000	2, 800	5, 125	1, 400	3, 300	282, 825
Sheboygan County, Wisconsin	373, 720	392, 215	6, 000	31, 550	3, 000	3, 500	809, 985
Ozaukee County, Wisconsin	5, 500	30, 000	1, 500		2, 000	3, 000	42, 000
Milwaukee County, Wisconsin	37, 750	690, 600	1, 200	24, 800	1, 500	206, 000	961, 850
Racine, Wisconsin	5, 000	168, 600	7, 000	6, 000		15, 300	201, 900
Kenosha, Wisconsin	106, 000	112, 600				8, 100	226, 700
Waukegan, Illinois	23, 500	4, 000	1, 200	500		4, 200	33, 400
Chicago and South Chicago, Illinois	81, 696		101, 362	75, 165		602, 952	861, 175
Indiana	134, 890	34, 215	175, 161	5, 500		98, 630	448, 396
Berrien and Van Buren Counties, Michigan	177, 092	255, 043	223, 690	25, 500		89, 800	771, 125
Allegan County, Michigan	199, 975	43, 425	139, 224		1, 000	16, 649	400, 273
Grand Haven, Michigan	57, 595	102, 405	55, 368	166, 196	2, 200	21, 015	434, 779
Muskegon and Montague, Michigan	55, 405	31, 206	189, 852	55, 212	1, 975	73, 457	407, 107
Oceana County, Michigan	80, 500	28, 535	86, 771	3, 950	7, 000	24, 152	230, 908
Mason and Manistee Counties, Michigan	236, 965	123, 057	9, 075	4, 500	300	7, 100	380, 997
Frankfort and South Frankfort, Michigan	766, 104	302, 519					1, 068, 623
Aral to Good Harbor, Michigan	13, 300	110	200				13, 610
Grand Traverse Bay and vicinity, Michigan	272, 000	223, 400	4, 000	9, 000		5, 000	513, 400
Charlevoix, Michigan	276, 190	359, 260	6, 000	1, 000		30, 000	672, 450
Little Traverse Bay, Michigan	88, 862	82, 608	156	10, 559		20, 000	202, 185
Cross Village and Good Hart, Michigan	32, 000	6, 000				2, 000	40, 000
Mackinaw City to Point Waugoshance, Michigan	4, 700	33, 150	350		800		39, 000
Beaver, Fox, and Manitou Islands, Michigan	136, 425	240, 275	56, 400	5, 000		140, 000	578, 100
Total	5, 458, 496	5, 239, 415	1, 383, 728	1, 857, 243	662, 860	2, 755, 073	17, 356, 815

Table of products of the fisheries of Lake Michigan in 1885—Continued.

Section.	Salted.							
	White-fish.	Trout.	Sturgeon.	Herring.	Suckers.	Pike and pickerel.	Miscellaneous.	Total.
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*
The North Shore, Michigan	1, 059, 890	202, 360	5, 000	30, 500	114, 960			1, 412, 710
Manistique and Thompson, Michigan	10, 000							10, 000
Point aux Barques to Point Detour, Michigan	153, 150	51, 050						204, 200
Bay de Noquet, Michigan	151, 800	81, 200		18, 100	33, 000	2, 000		286, 100
Escanaba and vicinity, Michigan	84, 400			34, 400				118, 800
Menominee County, Michigan	64, 800	23, 700		779, 600	15, 000	8, 000		891, 100
Marinette County, Wisconsin	58, 000		5, 000	100, 000				163, 000
Oconto County, Wisconsin	24, 300	1, 100		306, 400	25, 000	500	1, 400	358, 700
Suamico to Green Bay City, Wisconsin				50, 000	5, 500		500	56, 000
Bay Settlement to Namur, Wisconsin								
Little Sturgeon and vicinity, Wisconsin	10, 000			500		2, 000		12, 500
Sturgeon Bay and Canal, Wisconsin	16, 000	6, 500		14, 500				37, 000
Entrance of Sturgeon Bay to Death's Door, Wisconsin	78, 925	15, 590		9, 200				103, 715
Washington Island, Door County, Wisconsin	70, 000	27, 000						97, 000
Newport to Lily Bay, Wisconsin	64, 800	79, 800		39, 600	600			184, 800
Horn's Pier to Nero, Wisconsin	800	54, 900		5, 450				61, 150
Manitowoc County, Wisconsin	2, 000	42, 700		500				45, 200
Sheboygan County, Wisconsin	3, 700	14, 300						18, 000
Ozaukee County, Wisconsin								
Milwaukee County, Wisconsin	300	9, 700		300				10, 300
Racine, Wisconsin								
Kenosha, Wisconsin								
Waukegan, Illinois	5, 000							5, 000
Chicago and South Chicago, Illinois								
Indiana	2, 000			2, 000				4, 000
Berrien and Van Buren Counties, Michigan	4, 800	500						5, 300
Allegan County, Michigan	1, 100							1, 100
Grand Haven, Michigan	900							900
Muskegon and Montague, Michigan								
Oceana County, Michigan	1, 700	500	200			200		2, 600
Mason and Manistee Counties, Michigan	6, 600	22, 760	1, 000					30, 360
Frankfort and South Frankfort, Michigan	119, 400	42, 423						161, 823
Aral to Good Harbor, Michigan	118, 500	1, 100		1, 000				120, 600
Grand Traverse Bay and vicinity, Michigan	192, 000	178, 000			30, 000			400, 000
Charlevoix, Michigan	15, 100	22, 300						37, 400
Little Traverse Bay, Michigan	1, 000							1, 000
Cross Village and Good Hart, Michigan	120, 000	30, 000		10, 000				160, 000
Mackinaw City to Point Waugoshance, Michigan	5, 100	700		600	8, 100			14, 500
Beaver, Fox, and Manitou Islands, Michigan	729, 175	261, 400		44, 000	20, 000			1, 054, 575
Total	3, 175, 240	1, 169, 583	11, 200	1, 446, 650	252, 160	12, 700	1, 900	6, 069, 433

Table of products of the fisheries of Lake Michigan in 1885—Continued.

Section.	Smoked.					Total.	Value.
	White-fish.	Trout.	Sturgeon.	Herring.	Total.		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
The North Shore, Michigan						2, 124, 090	$81, 339
Manistique and Thompson, Michigan						920, 476	28, 327
Point aux Barques to Point Detour, Michigan						230, 200	8, 647
Bay de Noquet, Michigan						973, 579	34, 713
Escanaba and vicinity, Michigan						520, 294	13, 783
Menominee County, Michigan						954, 909	15, 290
Marinette County, Wisconsin						552, 000	15, 540
Oconto County, Wisconsin						1, 259, 139	24, 100
Suamico to Green Bay City, Wisconsin						1, 626, 400	26, 000
Bay Settlement to Namur, Wisconsin						513, 965	18, 454
Little Sturgeon and vicinity, Wisconsin						377, 055	15, 500
Sturgeon Bay and Canal, Wisconsin						303, 645	9, 225
Entrance of Sturgeon Bay to Death's Door, Wisconsin						448, 500	18, 658
Washington Island, Door County, Wisconsin						123, 400	6, 800
Newport to Lily Bay, Wisconsin						290, 500	7, 613
Horn's Pier to Nero, Wisconsin						514, 650	19, 098
Manitowoc County, Wisconsin						328, 025	13, 200
Sheboygan County, Wisconsin	31, 250		7, 050		38, 300	866, 285	52, 740
Ozaukee County, Wisconsin						42, 000	1, 500
Milwaukee County, Wisconsin				8, 100	8, 100	980, 250	46, 300
Racine, Wisconsin						201, 900	9, 710
Kenosha, Wisconsin						226, 700	10, 530
Waukegan, Illinois						38, 400	1, 980
Chicago and South Chicago, Illinois						861, 175	71, 880
Indiana			1, 700		1, 700	454, 096	17, 673
Berrien and Van Buren Counties, Michigan						776, 425	31, 101
Allegan County, Michigan						401, 373	16, 575
Grand Haven, Michigan						435, 679	16, 882
Muskegon and Montague, Michigan		300	3, 000	500	3, 800	410, 907	17, 052
Oceana County, Michigan						233, 508	10, 047
Mason and Manistee Counties, Michigan						411, 357	17, 193
Frankfort and South Frankfort, Michigan						1, 230, 446	51, 585
Aral to Good Harbor, Michigan						134, 210	17, 084
Grand Traverse Bay and vicinity, Michigan	6, 000	6, 000			12, 000	925, 400	32, 757
Charlevoix, Michigan	8, 000	16, 000			24, 000	733, 850	21, 819
Little Traverse Bay, Michigan	4, 000				4, 000	207, 185	8, 495
Cross Village and Good Hart, Michigan						200, 000	7, 625
Mackinaw City to Point Waugoshance, Michigan						53, 500	1, 563
Beaver, Fox, and Manitou Islands, Michigan						1, 632, 675	60, 410
Total	49, 250	22, 300	11, 750	8, 600	91, 900	23, 518, 148	878, 788

Table of products of the fisheries of Lake Michigan in 1885—Continued.

Section.	Manufactured products.				Total value of products.
	Caviare.	Isinglass.	Oil.	Value.	
	Lbs.	*Lbs.*	*Galls.*		
The North Shore, Michigan					$81, 339
Manistique and Thompson, Michigan					28, 327
Point aux Barques to Point Detour, Michigan					8, 647
Bay de Noquet, Michigan	2, 000	30		$235	34, 948
Escanaba and vicinity, Michigan					13, 783
Menominee County, Michigan					15, 290
Marinette County, Wisconsin					15, 540
Oconto County, Wisconsin	1, 920	150		400	24, 500
Suamico to Green Bay City, Wisconsin					26, 000
Bay Settlement to Namur, Wisconsin					18, 454
Little Sturgeon and vicinity, Wisconsin					15, 500
Sturgeon Bay and Canal, Wisconsin					9, 225
Entrance of Sturgeon Bay to Death's Door, Wisconsin					18, 658
Washington Island, Door County, Wisconsin					6, 800
Newport to Lily Bay, Wisconsin					7, 613
Horn's Pier to Nero, Wisconsin					19, 098
Manitowoc County, Wisconsin					13, 200
Sheboygan County, Wisconsin			50	20	52, 760

Table of products of the fisheries of Lake Michigan in 1885—Continued.

Section.	Manufactured products.				Total value of products.
	Cavaire.	Isinglass.	Oil.	Value.	
	Lbs.	*Lbs.*	*Galls.*		
Ozaukee County, Wisconsin					$1,500
Milwaukee County, Wisconsin					46,300
Racine, Wisconsin					9,710
Kenosha, Wisconsin					10,530
Waukegan, Illinois					1,980
Chicago and South Chicago, Illinois	230	80	80	161	72,041
Indiana	8,600		780	1,172	18,845
Berrien and Van Buren Counties, Michigan	23,125		1,700	2,989	34,090
Allegan County, Michigan	9,875	125	200	318	16,893
Grand Haven, Michigan	7,500	150	1,100	1,267	18,149
Muskegon and Montague, Michigan	5,725	250	375	1,036	18,088
Oceana County, Michigan	6,300	75		728	10,775
Mason and Manistee Counties, Michigan					17,193
Frankfort and South Frankfort, Michigan					51,585
Aral to Good Harbor, Michigan					17,084
Grand Traverse Bay and vicinity, Michigan			640	448	33,205
Charlevoix, Michigan	700	50	375	260	22,079
Little Traverse Bay, Michigan					8,495
Cross Village and Good Hart, Michigan					7,625
Mackinaw City to Point Waugoshance, Michigan					1,563
Beaver, Fox, and Manitou Islands, Michigan			2,000	600	61,010
Total	65,975	910	7,300	9,634	888,422

33. THE NORTH SHORE (MACKINAC AND SCHOOLCRAFT COUNTIES, MICHIGAN).

Fishing centers.—On the north shore of Lake Michigan from St. Ignace to Seul Choix Point, a distance of 75 miles, there are no villages, if we except a few small fishing communities. The fishermen are scattered at frequent intervals along the eastern portion of this coast, the principal settlements being at St. Helena Island, Gros Cape, and Point la Barbe; and further west there are three settlements, with post-offices, named Epoufette, Naubinway, and Orville. The shores as a rule are sandy, with no good harbors, and the soil, which is well wooded, is poor and uninviting to the agriculturist. The Beaver Islands, lying in the middle of the upper end of the lake, break the force of the waves along certain portions of this coast, which otherwise would be exposed to the wind sweeping without interruption over 300 miles of water. The abundance of fish in the locality has induced the fishermen to settle here, and the three hamlets already named have from ten to thirty families each, with as many more families scattered along the shore, chiefly in the eastern portion. There is a lumber-mill at Black River, locally known as Gilchrist, and another, not now in operation, at Naubinway, lumbering being the only interest aside from fishing.

History and character of the fisheries.—For fully thirty years the residents have fished extensively with gill-nets, and between 1856 and 1859 the first pound-net was set in the region near Naubinway, and by 1862 they were extensively used. The fishermen are, almost without exception, French Canadians, with an admixture in many cases of In-

dian blood. A few have been very successful in the prosecution of the fisheries, some having accumulated considerable property from this source. A small percentage own pound-nets and others have mackinaw boats and gill-nets, but the majority are content to work for wages varying from $20 to $35 per month. A few boats are owned by the dealers and fished on shares, but a majority of the apparatus is purchased outright or obtained on credit from the dealers, to be paid for with fish. The gill-net boats begin fishing in early spring at St. Helena Island and on the adjacent shore, coming later to Seul Choix, where they remain until the middle of September. The men then return to their homes, put their nets in order, and by the first of October begin fishing in the vicinity of Naubinway and Gros Cape, where they remain until late in December. The pound-nets are used from June till September, when many of them are taken out and moved to other localities for the fall fishing, some of the fishermen setting additional nets at this season. Herring were formerly extensively taken about Gros Cape, but the catch has been much reduced in recent years, and fewer herring pound-nets are now fished.

Statistics of men, apparatus, and capital.—During 1885 there were 178 fishermen, distributed as follows: Seventy-eight at Gros Cape, St. Helena Island, and vicinity; 25 at Epoufette; 36 at Naubinway; 39 at Orville (locally known as Scott's Point) and Seul Choix. Forty-six of the men were engaged in tending the 68 pound-nets, and 122 others were employed on the 55 gill-net boats, two or three men constituting a crew, with about 100 nets to the boat.

The total capital invested in the fisheries was $83,895, divided as follows: Two collecting tugs, $4,000; 55 gill-net boats, 33 pound-net boats, 3 seine-boats, 19 pile-drivers, 16 rafts, and 13 small boats, $11,635; 5,580 gill-nets, 1,513,350 feet in length, $30,492; 68 pound-nets, $27,275; 3 seines, 16,200 feet in length, $225; 100 spears, $300; wharves and buildings, $4,600; other apparatus and accessories, $3,448; working capital, $1,850.

Products and trade.—The catch consists chiefly of whitefish, with considerable quantities of trout and a few sturgeon, suckers, and herring, suckers being usually thrown away, and many of the sturgeon sharing the same fate. Until recently the entire catch was salted, but for the past few years steam and sail collecting boats have visited the locality from Mackinaw Island, Manistique, and St. James, and purchased considerable quantities of fish, which are packed in ice and sent to Detroit and Chicago. In 1885 the catch for this portion of the coast amounted to 538,266 pounds of whitefish, 10,420 pounds of Menominee whitefish, 135,444 pounds of trout, 10,000 pounds of sturgeon, 4,720 pounds of herring, 12,530 pounds of suckers, sold fresh; and 989,990 pounds of whitefish, 26,000 pounds of Menominee whitefish, 202,360 pounds of trout, 5,000 pounds of sturgeon, 30,500 pounds of herring, and 114,960 pounds of suckers, salted. Of the salt whitefish 868,300 pounds were No. 1,

PLATE XIX.

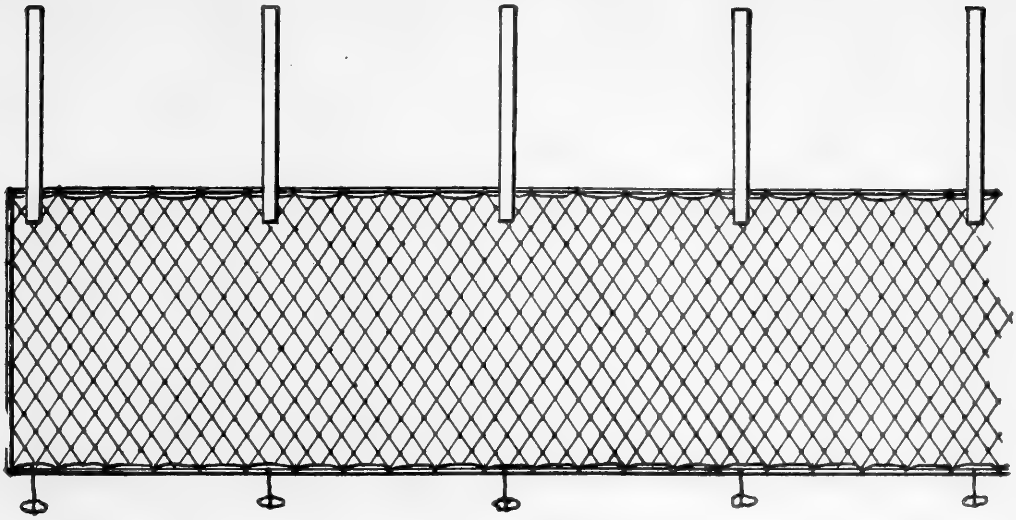


Fig. 2.

Fig. 1.

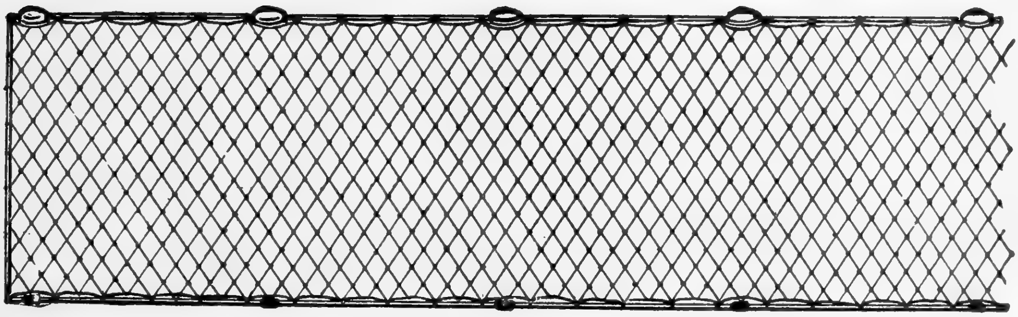


Fig. 3.

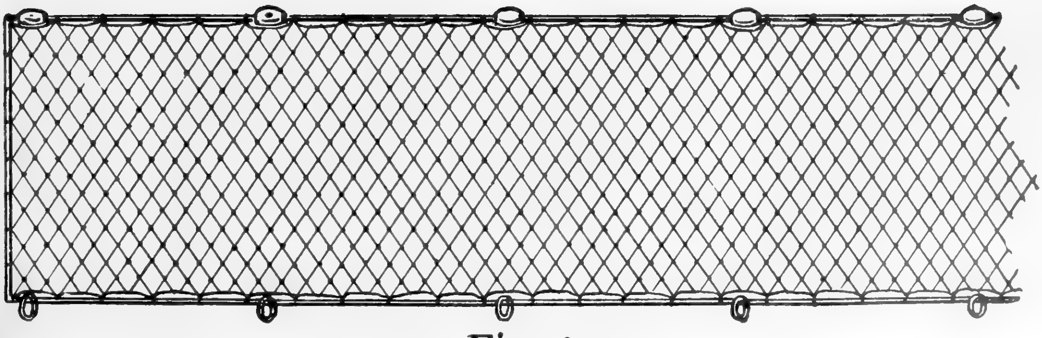


Fig. 4.

GILL-NET RIGS.

FIG. 1. Float and stone rig.
FIG. 2. Sectional view of float.

FIG. 3. Cork and lead rig.
FIG. 4. Cork and ring rig.

73,940 pounds No. 2, and 91,650 pounds No. 3. The total value of the yield was $81,335, of which $58,004 were for salt fish and $23,335 for fresh fish. The prices paid to the fishermen in 1885 were 3½ to 4 cents per pound for fresh whitefish and 2½ cents for trout; the salt whitefish bringing from $4.50 to $5 per package for No. 1, $4 to $4.50 for No. 2, and $2.50 to $3 for No. 3, and the salt trout selling for $3 to $3.50. The fresh fish go wholly to Chicago and Detroit, while the most of the salt fish are sent to Chicago, and a few to Cleveland, Detroit, and Buffalo.

Gill-net fishery.—From the earliest settlement of the region gill-nets have been the most important form of apparatus used. The nets are 40 to 45 fathoms long, 4½- to 6-inch mesh, and twelve to sixteen meshes deep. A few cork and lead nets are employed, but fully three-quarters are provided with the old-fashioned form of float and stone. The boats, which carry from two to three men, are fitted with fifty to one hundred and fifty or in some cases as many as two hundred nets, these being fished in gangs of from twenty to thirty each. When new, the boats, which are large well-built mackinaws, cost from $175 to $200, including sails. The fishing frequently begins by the middle of April and by the first of May all of the fishermen are at work, as the catch for the first two or three weeks after the ice breaks up is unusually good. By the middle or last of May fully half of the fishermen of the locality have collected about Seul Choix, where whitefish of large size are abundant. Here they build shanties and remain during the entire summer, selling a portion of their fish fresh to collecting steamers from Manistique, and salting the remainder. About the middle of September they leave for their homes and spend a month or six weeks in repairing their nets and getting ready for the fall fishing, at which time they catch large quantities of trout, and, by the last of November, a good many spawning whitefish. They continue their work until the ice interferes, which is usually about the 10th or 15th of December. The catch for those having a good outfit of nets and fishing steadily occasionally reaches 400 packages; but a fair average for the entire coast is about 225. About 65 per cent. of this catch is whitefish, the remainder being almost exclusively trout. The average whitefish will weigh about 2¼ pounds and the average trout 3 or 4 pounds.

Gill net fishing through the ice.—Gill-nets are occasionally fished through the ice in winter, but there is no regular fishing, except in the vicinity of St. Helena Island, Naubinway, and Epoufette. Here about a dozen or fifteen crews are fishing with more or less regularity for five or six weeks. They run from twenty to thirty nets each and catch an average of 2 or 3 tons, the fish being sold fresh in the vicinity to dealers at St. Ignace and Mackinaw Island.

Pound-net fishery.—In 1860 over 1,400 half-barrels of salt fish were taken in a 16-foot net at Biddle's Point, this being the largest catch ever known along this shore. The pounds in former times were set in

15 to 20 feet of water, but since 1883 deeper nets have been employed, and they are now set in water varying from 30 to 60 feet. The leaders, which are of 6-inch mesh, are from 495 to 990 feet long, and the pound proper is from 28 to 35 feet square, with 2- to 3½-inch mesh. The average value of the nets is about $350. The fishing season begins early in June and is very extensive till the middle of July. The nets are operated well into September, and some of them remain in throughout the entire season. Some of those taken out are not reset, but a majority are moved to other localities and fished for whitefish during the spawning season. Formerly most of the nets were between St. Ignace and Naubinway, but now there are few nets east of Epoufette. The majority are in this vicinity and at Seul Choix, where whitefish averaging 5 and 6 pounds are taken, some individuals weighing 12 to 15 pounds being occasionally secured. The average catch for a pound-net is estimated at 11,500 pounds, made up as follows: 80 per cent. whitefish, 6 per cent. trout, 4½ per cent. sturgeon, and 9½ per cent. lawyers, herring, and other fish having no commercial value.

The pound-boats are large and well built, many of the keeled boats being 18 to 25 feet long, worth $175 to $225, while the smaller flat-bottomed boats, with sails, have a value of $75 to $125. Formerly the pile-drivers were mounted upon two boats lashed together, but now most of the fishermen build rafts of cedar logs, claiming that the stakes can be driven much more securely and in a shorter time in this way. Only one or two instances have occurred where pound-nets have been frozen into the ice and fished during the winter, these as a rule not being sufficiently successful to warrant further operations in this line, and for some years no pound-nets have been fished in winter.

Seining.—This has never been important along the north shore, and the only seines now fished are two or three which are used in the capture of suckers in spring.

Hand-lines.—Hand-lines have been employed to some extent for several years. About 1880 a dozen or more of the fishermen used them to a considerable extent, but in 1885 they were seldom employed except by the Indians and others to obtain a supply of salt fish for their own consumption.

Other fisheries.—No fykes or trammel-nets are employed in the fisheries here. The spearing is not extensive, though forty or fifty men use spears occasionally during the winter, and about ten or twelve Indians engage in the work with considerable regularity, freezing their fish and selling them fresh at St. Ignace.

34. MANISTIQUE AND THOMPSON, SCHOOLCRAFT COUNTY, MICHIGAN.

Description of the villages.—Manistique and Thompson are two lumbering settlements of considerable importance, the former located at the mouth of the Manistique River, in the county of Schoolcraft, and the latter about 6 miles further west. The first-named city is owned by

the Chicago Lumber Company, which, owning both the land and water privileges, has a monopoly of the business interests, and has erected three saw-mills, and, in addition, a large number of dwelling-houses, which are rented to the mill hands. Thompson is also an important lumbering town, this being the principal business of the place.

Character of the fisheries.—The fisheries of this region were formerly in the hands of Indians, who fished with gill-nets and salted considerable quantities of whitefish and trout. Since the lumber companies have obtained possession, the fishing privileges of Manistique are controlled exclusively by a Chicago firm, which has a large ice-house and two collecting steamers, with one tug and one sail-boat engaged in the gill-net fisheries. It has, in addition, five pound-nets fished on shoals a few miles from shore, off the settlement of Naubinway. The fishery privileges of Thompson are controlled by a Detroit firm, which established a fishing station at Thompson in 1884. It now has six pound-nets, three located near the village and three others about 12 to 15 miles further east. In addition it has two steamers engaged in fishing gill-nets, and last year employed also a sail-boat. Four gill-net boats are owned by fishermen of Manistique and two belong to those living at Thompson; but the fishermen leave these settlements and build camps on the shore between Point aux Barques and Point Detour, salting a large part of the catch and selling occasional lifts fresh to the collecting boats.

Shipments.—The firm at Thompson catches its own fish and ships them fresh to Detroit, but the firm at Manistique, in addition to its own tug and boat fisheries, is extensively engaged in buying fish from the pound-net and gill-net fishermen along all portions of the north shore between St. Helena Island and Point Detour, including the Beaver Islands. In the spring and summer, when the catch of the pound-nets about Seul Choix is extensive, a majority of the fish are purchased in this locality, but later the collecting tugs buy from the Beaver Islands, Epoufette, Naubinway, and Orville fishermen, going occasionally to Gull Island. A portion of the fish are shipped direct to Chicago, and the remainder are sent to the freezing establishment belonging to the same firm at Escanaba, at the head of Green Bay, where they are placed in refrigerators and kept until the demand and prices will warrant their shipment.

Statistics.—During 1885 these firms employed at Thompson and Manistique 26 fishermen and 27 shoresmen and preparators. These fished 11 pound-nets and 530 gill-nets, using 3 fishing tugs, 2 collecting tugs, and 1 sail-boat. The capital invested in boats, apparatus of capture, fish-cars, shore property, etc., amounted to $56,645. These figures do not include those gill-net fishermen who prosecuted their fishing along the coast further west, and who are included with the fisheries of the region where their camps were located. The catch of the fishermen of Manistique and Thompson in 1885 amounted to 392,219 pounds of whitefish,

512,907 pounds of trout, 4,000 pounds of sturgeon, 1,350 pounds of other fish, and, in addition, 100 half-barrels of salt fish, worth $475, making the total value of the catch $28,327.

Trade.—As previously stated, one of the firms operating the fisheries of this region was extensively engaged in purchasing fish from the fishermen along the entire north shore. In 1885 the fish thus handled were as follows: 355,800 pounds of fresh whitefish, 78,230 pounds of fresh trout, 21,600 pounds of fresh sturgeon, and 5,200 pounds of other fresh fish; and the following quantities of salt fish, viz, 20,000 pounds of No. 1 whitefish, 15,000 of No. 2 whitefish, 10,000 pounds of No. 3 whitefish, 5,000 pounds of trout, and 3,000 pounds of herring.

35. POINT AUX BARQUES, SCHOOLCRAFT COUNTY, TO POINT DETOUR, DELTA COUNTY, MICHIGAN.

Character of the fisheries.—The fisheries between Point aux Barques and Point Detour are of comparatively little importance. A few gill-net fishermen live in the section, and others from Thompson and Manistique build fishing shanties, where they remain with their boats and gill-nets during the fishing season. Some of them are provided with small set-lines, which they use in connection with their gill-nets to a limited extent. The greater part of their catch is salted, though a few fish are sold fresh to the collecting boats from Manistique.

Statistics.—In 1885 there were fourteen crews, consisting of thirty men, with 14 boats and 1,400 gill-nets, fishing along this shore, chiefly in the vicinity of Little Harbor and Craig and Portage Bays. Eleven thousand and sixty-eight dollars were then invested in the fisheries of this section, of which amount the gill-nets alone were valued at $8,050. The catch amounted to 19,500 pounds of fresh whitefish, 6,500 pounds of fresh trout, 153,150 pounds of salt whitefish, and 51,050 pounds of salt trout, the entire yield being valued at $8,647.

36. BAY DE NOQUET, DELTA COUNTY, MICHIGAN.

Geographical description.—Although the main waters of Green Bay extend in a southerly direction from its mouth at the Port des Morts, it sends up two arms to the northward, known, respectively, as the Bay de Noquet and Little Bay de Noquet, or more familiarly among the fishermen as "Big Bay de Noc" and "Little Bay de Noc." The former is the one first entered by the navigator who rounds Point Detour. It is about 25 miles long and some 12 miles across at the widest point. The shores are rather sparsely settled. The peninsula which separates it on the east from the open waters of Lake Michigan has a scattered agricultural population, with landings and small settlements on the bay shore at Garden, Fayette, Sack Bay, and Fairport. On the western shore, near the head of the bay, are the hamlets of Brompton, Nahma, and Ogontz.

Fishing centers.—The principal fisheries are those with pound-nets at Long Point, above Peninsula Point, the western promontory of the bay, and with gill-nets from Sack Bay, just below Fayette. Nahma, although its name is the Ojibway word for sturgeon, and was first suggested by the abundance of that species in the vicinity, is inhabited only by the hands employed in the single saw-mill which gives the place its existence. A crew of pound-net fishermen from Oconto make their headquarters there, however, during the fishing season. Ogontz is the headquarters of a single crew of pound-net and fyke-net fishermen, and another firm belonging at the village fishes from the vicinity of Fayette. Brompton is entirely without fishing interests. The village of Garden is a little inland, and there are only about a dozen houses at the dock. It has a large mill and a store connected with it, and one pound-net fisherman lives a short distance above the landing. Some of the residents of Garden are engaged in burning charcoal for the blast-furnace at Fayette. Fayette has no saw-mills, and, apart from the furnace, is mostly dependent upon the trade with the inland farming community. An Ogontz firm has a fish-house on Snake Island, close to the village, from which it operates important pound-net fisheries. Several miles south of the last-named place is Sack Bay, where there are about fifteen families of fishermen. Summer Island, lying just off Point Detour, was once the home of fifteen or twenty families, all of them more or less dependent upon the fisheries; but in 1885 there remained only four families, with two crews of fishermen. Rocky Island is entirely barren, and is at present uninhabited. It frequently happens, however, that fishermen from Sack Bay, Fairport, or elsewhere, spend a month or two on the island with their families during the height of the season. When fishing was good a number of people lived there permanently and had a school-house and school-teacher.

Fishermen.—Most of the fishermen of the bay are Americans, but there is a small sprinkling of Swedes and other nationalities.

Species.—The principal species obtained are trout, whitefish, and sturgeon. Many hundred dollars' worth of herring and wall-eyed pike or "dories" are taken, particularly in the pound-nets; and the remainder of the catch is made up of the little-esteemed varieties, such as perch and suckers. The lawyers are considered worthless and are thrown away. In the vicinity of Sack Bay very few herring or suckers are found. The catch in the western part of the Bay de Noquet is principally whitefish, with hardly any trout; in the eastern part there is a great preponderance of trout. The proportion of whitefish is much larger in the fall than in the spring. Near its head the sturgeon is the principal species, and pike are found in considerable numbers, while black bass also form an appreciable element in the catch.

Weight and prices.—The whitefish average from 2 to 3 pounds in weight, and bring about 4½ cents per pound fresh. When salted they usually sell for about 4 cents per pound for No. 1, 3½ cents for No. 2,

and 1¾ cents for No. 3. The trout average 4 pounds in weight, and bring from 2½ cents to 4 cents per pound. The price of herring is about 2 cents.

Preparation and trade.—Apart from the salted products, about all the fish shipped from the Bay de Noquet pass through the hands of firms at Fairport or at Escanaba. The collecting steamers belonging to these firms make the round of the fishing stations at frequent intervals. Some of the salted fish are shipped directly by the fishermen; others are sold at Sack Bay, from whence they are shipped, mostly to Chicago. In 1884 three thousand hundred-pound packages, including a good many purchased from the fishermen of Point aux Barques and the islands, were handled by a Sack Bay firm; but the official returns made for 1885 show only six hundred and fifteen packages shipped in that year. The firm purchases no other fish, and sells those from its own pound-nets to the two fresh-fish firms.

There is very little utilization of secondary products in this region. The firm at Snake Island and the Oconto fishermen at Nahma save the sounds of the sturgeon, and the last named make caviare from the eggs. No oil is made, except a little occasionally tried out by the fishermen for their own use.

A Fairport firm built a capacious freezer in 1884, and about 47 tons of fish were frozen in it before the close of the season. About half of that quantity was whitefish, 4,200 pounds herring, and the rest trout, with a few scattering pickerel (*i. e.*, wall-eyed pike). They were shipped to Chicago in the early part of 1885. The same firm salted six hundred packages of the fish caught in its own pound-nets, but did not handle any other salt fish.

Statistics.—The total number of men employed in the fisheries of the Bay de Noquet in 1885 was 105, besides 10 shoresmen engaged in the handling and preparation of the products. A moderate estimate of the population directly dependent on these would be 250. The number of gill-net boats was about 20, of pile-drivers and pullers 8, and of small row-boats, not elsewhere included, 5. One steam-tug and two schooners were employed in collecting fish, and three tugs in gill-net fishing. The entire value of the vessels was $13,000, and of the boats $10,325. Three thousand two hundred and forty gill-nets, equal to 135,600 fathoms, and 44 pound-nets were used, besides one seine and a number of fyke-nets. The capital invested in these apparatus of capture was $36,145, in buildings and wharves $21,500, and in fixtures and minor apparatus $4,350, besides a cash capital of $23,000, making a total of $108,320.

The products sold fresh in 1885 were 265,278 pounds of whitefish, 262,563 pounds of trout, 99,192 pounds of sturgeon, 15,731 pounds of wall-eyed pike, 29,715 pounds of herring, 4,000 pounds of black bass, and 11,000 pounds of miscellaneous fish, nearly all perch and suckers. Those salted amounted to 1,518 packages of whitefish, 812 packages of

wall-eyed pike, 181 packages of herring, and 330 packages of other fish. The total value of these products, including 291 sounds, and 2,000 pounds of caviare obtained from the sturgeon, was $34,948.

Pound-net fishery.—About half of the pound-nets in the bay are set on the west side, most of them in the immediate vicinity of Long Point. The greater part of them are owned by fishermen who live at their fish-houses near by during the fishing season, but return when it is over to their winter homes at Little Sturgeon, Michigan, and Menekaunee, Wisconsin.

Another group of nets, including about a quarter of the whole number, occurs at the head of the bay between Ogontz Bay and Fish Dam River, and the remainder are scattered along the eastern shore and among the islands near the entrance of the bay. Thirteen of the pound-nets are owned at Garden, Fairport, and Sack Bay, seven at Snake Island and Round Island, eleven by the firms fishing from Nahma and Ogontz, and thirteen at Long Point, where they have been fished since 1861.

The pound-nets used have a mesh of 2½ to 4 inches in the pot, and an average length of 1,320 feet. They are set in water from 20 to 68 feet deep, averaging about 45 feet. They are worth from $350 to $800, averaging $475. The boats usually range in value from $25 to $100. The catch of the Long Point fishery consists mostly of whitefish. The fish sold fresh from that place include only about 5 per cent. trout, 3 per cent. sturgeon, and a little less than 3 per cent. dories or wall-eyed pike. In 1885 the proportion of trout was unusually large, and would amount to 6 or 7 per cent. In the nets fished from Garden the proportions in 1884 were 55 per cent. sturgeon, 25 per cent. wall-eyed pike, 10 per cent. whitefish, and 15 per cent. perch.

Nearly every crew is provided with a pile-driver worth about $25, and occasionally an additional scow with a stake puller is owned. Several vessels are used in connection with the pound-net fishing. At Fairport the steamer *Oliver C. Williams*, 57.78 tons, and schooner *Mary A. Gregory*, 83.13 tons, are employed in tending the pound-nets as well as in purchasing fish. During most of the season the schooner *Merchant*, 62.72 tons, is used for running to and from the nets, the fishermen living on her. The fishing begins at the head of the bay about the middle of May, and at Long Point the first of June. The fishing at Long Point is usually suspended during July and August.

The catch is far from being so large as in former years. It is claimed that about twenty-three years ago as many as 300 half-barrels of fish were sometimes taken from two pound-nets at one lift. In 1884 the total yield from thirty of the pounds, for which an accurate record was kept, amounted to $14,809, of which about three-fourths was for fresh fish.

Gill-net fishery.—No gill-nets are used in the Bay de Noquet, except in the little settlement included in the Fayette post-office. Sack

Bay takes the lead with 1,560 nets. Four hundred of these were fished in 1885 by the steamer *Sarah A. Shipman*, 8.84 tons, and the remainder by eleven sail-boat crews. At Fairport there was one small tug, the *Daisy Moore*, 5.76 tons, and four sail-boat crews, using altogether 975 nets. The steamer *Maggie Lutz*, 8.14 tons, of Sheboygan, Wisconsin, fished with 300 gill-nets in the Bay de Noquet and the neighboring waters of the lake.

At Summer Island, just outside the limits of the Bay de Noquet, but naturally included with the latter, only two men owned gill-net boats in 1885, and before the close of the year one of these removed to Sack Bay.

The gill-nets in this region are from 35 to 40 fathoms in length, and have a mesh of 4 to 4½ inches. From a pound to 2½ pounds of twine are required to each net, according to the degree of coarseness, there being considerable variation in this particular. Rigged with float and stone, as they usually are, they cost from $4 to $4.50 apiece. It is interesting to note that in Sack Bay the method of rigging with cork and lead, after having been tried by the fishermen for several seasons, has been entirely discarded in favor of the old method. Four-fifths of the nets at that place in 1884, and all of them in 1885, had floats and stones. In the spring and summer the nets are generally set in the lake in 50 fathoms of water, but in the fall they are fished in the bay, sometimes in only 15 fathoms. The favorite fishing-ground in the open water is about 7 miles out from Big Summer Island.

The boats are usually built in the mackinaw style, and range in value from $75 to $225, but average a little less than $150. Those at Sack Bay are all mackinaws. They are about 26 feet long, with a 6½-foot beam. Some are carvel-built and others are lap-streaked. Each of them has two fixed masts, the foremast slightly the longer, a fixed bowsprit and one jib. The mainsail has both gaff and boom, but the foresail is loose-footed with a gaff. Both of the sails are bent to mast-hoops. All the boats have center-boards, with a box 4½ to 5 feet long. The wash-board is 5 inches broad at the middle and 2 inches at the stern, with a coaming throughout, and in some cases an additional board 3½ inches high outside the coaming, for 9 feet abaft the bow. There are two thwarts, the forward thwart 7 or 8 feet abaft the bow, and the after thwart about 11 feet forward of the stern.

The gill-net season lasts from April to November. Those who engage in this fishery devote to it their exclusive attention during the season, and there is but one instance of a crew which fishes pound-nets at the same time. Some of the men lay off for a while in summer; for example, the captain of the *Daisy Moore* uses her in fishing in spring and fall and in towing logs in summer. Half of the crews at Sack Bay stop during September and resume work in October. There are one or two crews that fish only in the spring. Before the water is frozen over all fishing has ceased. Occasionally a stray net is set under the ice but only for home supply.

At Sack Bay the number of crews has remained about the same for a quarter of a century. There have, however, been several improvements in the methods of fishing, the principal being the introduction of steamers. Among the sail-boat fishermen the number of nets fished by each crew has increased; at Sack Bay, for instance, it was said to be one-third greater than in 1870. On the other hand there has been a decrease in the average quantity of fish caught by each net. Now, as in the past, there are usually two men to each crew, and occasionally three. In summer fishing it is customary to keep four gangs of fifty nets each in the water, and the remainder of the nets on deck.

In 1884 the gill-net fishermen of Sack Bay averaged 4,500 pounds of fresh and 42 half-barrels of salted fish to each boat. In 1885 the average was larger, though the fish were of poorer quality. Through the kindness of Mr. Wells we are able to present the following table, showing the monthly catch of his fishing steamer during the year 1884:

Month.	Whitefish.		Trout.	
	Fresh.	Salt.	Fresh.	Salt.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
May	2, 375	....	2, 910	....
September	372	1, 100	458	....
October	899	....	1, 584	4, 900
November	1, 361	....	10,328	....
December	2, 609	....	192	....
Total	7, 616	1, 100	15, 472	4, 900

From this some idea may be obtained of the comparative productiveness of the fishing in different portions of the year.

Other fisheries.—Pound-net and gill-net fisheries comprise all of the fishing interests of the region with the trivial exceptions of one small seine, a few fyke-nets, and a very little hook and spear fishing through the ice for home supply. About 4,000 pounds in a season are caught with set-hooks and snatch-hooks. The seine is fished for suckers by one of the pound-net crews in intervals of leisure. The fyke-nets also are fished in connection with pound-nets, most of them at the mouth of Fish Dam River. The spearing is done by the Indians at Sack Bay and elsewhere.

37. ESCANABA AND VICINITY, DELTA COUNTY, MICHIGAN.

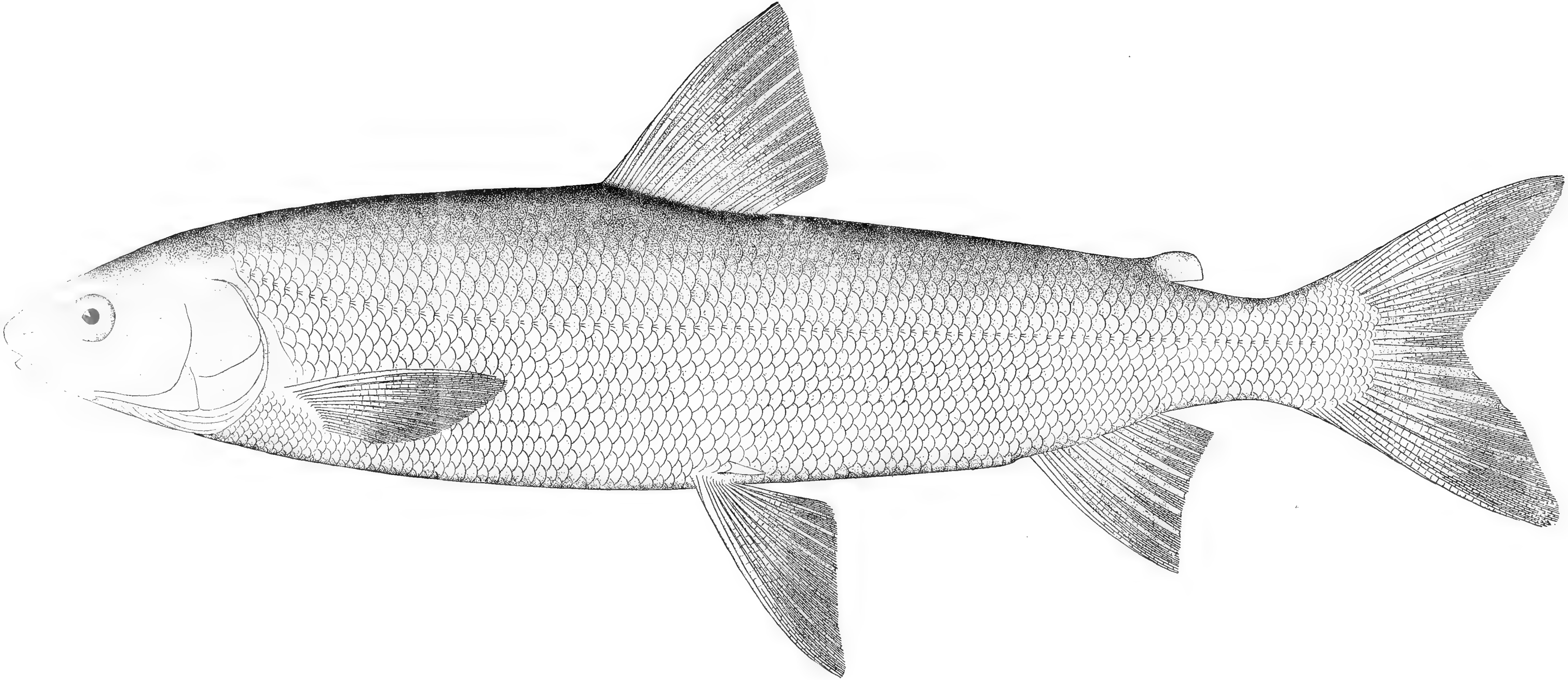
Geographical description.—Little Bay de Noquet, although nearly 20 miles in length, is only 7 miles wide at its mouth, and at one point narrows to a little more than a mile, its mean width being no more than 3 or 4 miles. Four small rivers enter it near its head and a still smaller stream near Squaw Point on its eastern side, but the principal tributary is the Escanaba River, which empties into it from the west 6 or 7 miles above the point where it joins the larger bay. At, and a few miles below, its

mouth, respectively, are the Ford and Bark Rivers, which, with the short strip extending from the latter stream to the boundary line between Delta and Menominee Counties, will naturally be included in the present discussion. The waters of the bay are from 4 to 15 fathoms in depth, averaging about 7 fathoms. Large shoals, covered with 3 to 18 feet of water, occur below Squaw Point on the eastern side, and between Escanaba and Ford River on the west. Below Indiantown the bottom shelves abruptly off from the shore to a depth of 4 or 5 fathoms, increasing to from 7 to 12 fathoms at a distance of 2 miles.

Fishing stations.—The only noteworthy settlements on the bay are the little village of Masonville, near its head, and the city of Escanaba, which is the center of the fishing interests of the whole region. The present prominence of Escanaba as a fishing center began in 1880, when a freezer was built, and by fall it was ready to receive its first fish. Six men are now employed there the year round in handling the fish, with three or four extra hands during the height of the season. At the mouth of Ford River is Misery Bay, where there live two or three families, several members of which are engaged in the pound-net fishery, and Indiantown lies about half-way between Ford and Bark Rivers.

Extensive pound-net fisheries are carried on, and there are a number of seine and gill-net crews working in summer, besides considerable winter gill-net fishing through the ice. Most of the pound-nets belong at Escanaba, and the greater part of the seines are owned and fished at Masonville.

Species.—Whitefish are by far the most important species to the fishermen of this region. In addition to the common whitefish several special varieties are distinguished by the fishermen, principal among which are the blackbacks or menominees (*Coregonus quadrilateralis*) and the bluefins or blackfins (*C. nigripinnis*). Very few long-jaws (*C. tullibee*) are obtained. In 1884 about one-fourth of the whitefish from North Point were bluefins, though none of that kind were found until after the middle of October. Two years previously nearly all from Long Point were bluefins and this variety made up most of the entire catch of the region. The blackbacks are fish weighing from 4 to 6 pounds each, said to be native to this bay. No siscowet are found in this or any other branch of Green Bay, as the water is not of sufficient depth, and even the ordinary trout are very scarce here. Whitefish constitute the principal catch of both the pound-nets and gill-nets. A few trout are obtained in the pound-nets and a great many by the gill-net fishermen. Pike and pickerel, here classed together as dories, are caught mostly in the seines, but are also obtained to some extent by the pound-net fishermen. They are rarely or never secured in the gill-nets. Herring are taken only in the pound-nets, and mostly during their spawning run in the late fall and early winter. Sturgeon are caught by the pound-nets for several months in the year. Black bass and bull-heads are obtained



WHITEFISH (*Coregonus clupeiformis*).

Natural size of artificially propagated specimen raised at Northville, Michigan; 3 years and 2 months old; weight, 17¼ ounces

in the seines. Perch and suckers make up the remainder of the catch of the pound-net and seine fishermen.

Collecting steamers.—The small steamers, *Maxwell* and *Hahn*, were used in buying fish for Escanaba from the fisheries of the surrounding region until June, 1885, when they were transferred to Manistique. The 30-ton steamer *Francis R. Anderson* was built in Chicago, in the fall of 1884, to take their place at Escanaba, and now makes regular collecting trips around Big and Little Bay de Noquet. She has a speed of 12 miles an hour. It is claimed that the steamer *A. Booth*, which was here in 1884, can run 18 miles an hour, though her usual speed is 12 miles. In May, 1884, the steamers *Hahn* and *Maxwell* began operations, and stopped in August, during which time they collected 165,628 pounds of whitefish, 71,505 pounds of trout, 8,948 pounds of sturgeon, and 6,433 pounds of dory. The steamer *A. Booth* collected, from May to November of the same year, 128,562 pounds of whitefish, 66,219 pounds of trout, 1,000 pounds of sturgeon, 1,481 pounds of dory, and 6,364 pounds of herring. It is customary with Booth's steamers to give checks in payment for the fish. These are used as currency and taken at par by the stores in the vicinity, which often remit them to wholesale grocers in the larger cities by whom they are sent to the banks for collection. In this way the "fish currency" very frequently goes to Chicago, and sometimes to places as remote as New York and Boston.

Detailed description of freezing house.—Through the kindness of Mr. Miles, Messrs. A. Booth & Sons' superintendent at Escanaba, we were enabled to make a thorough inspection of their freezing establishment, the results of which are embodied in the following description:

The freezer is a three-story wooden structure, with a value of about $8,000. Adjoining it is an ice-house, worth one-fourth as much more, in which is kept a supply of block ice packed in sawdust.

Before being used, the ice is crushed, in a machine made in Philadelphia, by means of a revolving iron cylinder with wrought-iron teeth about 4 inches long, which play between knife-like projections an inch and a quarter long, attached to the bar across the bottom of the opening through which the ice is driven. In this formidable apparatus 5 or 6 tons of ice may in twenty minutes be reduced to a mealy mass, the greater part of which is pulverized to the condition of snow, and it contains no pieces over 2 inches long.

Along the side of a room on the lower floor of the freezing-house are four wooden stalls or freezing-bins. They are open in front, but when partially or wholly filled may be closed with loose boards. Across the apartment are the washing-tanks.

On the second floor, in another part of the building, are the refrigerating or storage rooms. They are 26 feet long on the inside, and from 10 to 15 feet wide, and are separated from each other by heavy partitions made of matched pine boards, with a 6-inch packing of pulverized charcoal. The sides, and in some cases the ends of the rooms

are lined with galvanized ice-tanks 5 feet in length and 6½ feet high. The sides of these are composed of galvanized sheet-iron, the ends of wood 2 inches thick, and the bottom of 2 by 4-inch stuff; they are 8 inches wide at the top, narrowing to 3¾ or 4 inches at the bottom, and are placed about 4 inches from the wall in order to expose their entire surface to the chilled air. Both the rooms and the tanks open only at the top, and are reached through hatchways from the floor above.

The tanks hold from 3 to 6 barrels of ice each. In winter they are supplied once a week, but in summer, in order to keep them filled, it is necessary to charge them every day, as they lose fully one-third their contents by melting every twenty-four hours. The water thus formed falls into a galvanized iron gutter, which leads to a small tube at the end of the tank, through which it flows into long draining-troughs that run from the end to the center of the room. The tanks are lifted on standards about 1 foot above the floor, in order that the draining-troughs may be placed at a slant giving a fall of 1 foot to each. This is to prevent the ice from forming in them, as it has sometimes done, producing some inconvenience. The water from the drain under the cooling-tank is conducted through the floor of the refrigerating-room by a short standing pipe, protected by a little drop-cap filled with water, suspended from the ceiling of the room below. The water falling into the bottom of the cup flows over the top into the waste-pipe. Every spring the tanks are washed to rid them of sawdust and dirt.

When the fish come in they are first dressed, then put into the washing-tanks with ice-water, thoroughly cleansed, and afterwards packed with their backs up and their heads toward the outside, in galvanized iron pans 16 by 29¼ inches wide and about 3 inches deep, which are said to hold from 35 to 50 pounds, averaging 40 pounds. The large fish are packed lengthwise and small ones, such as herring and perch, crosswise. In the case of the pike a little water is put into the pans, as they do not contain sufficient moisture to hold them to each other when frozen, as is the case with other species.

The bottom of the wooden bins is covered with a layer, 3 inches deep, of crushed ice mixed with salt. Upon this are spread the first tier of pans, with their contents, and separated from the next tier above by 2 inches of ice and salt. In case of perch and other small fish, two tiers of pans instead of one intervene between each two layers of ice. This is repeated until the entire bin is filled. For freezing 5,000 pounds of fish 6 or 8 tons of ice and 3 barrels of salt are required. The pans are left in from ten to twelve hours, by which time the entire contents of each are frozen solidly into a single block. The fish are then packed in wooden storage boxes 30 inches long, 16 inches wide, and 12½ inches deep, inside measurement.

After four of the frozen cakes have been placed in the box it is nailed up before sending to the refrigerating-room to which it is to be assigned. In some other freezing establishments the box is dipped in water after

being packed, but this is not thought to be necessary. The boxes are hoisted to the second floor by a steam-elevator, from which they are transferred to little flat hand-cars, which run on parallel tracks across the room over the refrigerating apartments. The boxes are lowered through the hatches into the rooms below by means of a tackle suspended from the roof. Each room will hold seventy to eighty boxes when corded. Sturgeon and individual fish of other species, which happen to be too large for the pans, are not treated at all in the bins, but are hung up instead upon large meat-hooks in these refrigerating-rooms to be frozen, after which they are piled up like cordwood. The temperature of the rooms is usually about 14° Fahr. When the room has been emptied of its fish the ice is knocked from the tanks, upon the surface of which it accumulates to the thickness of an inch or two, and by means of a salamander stove, using gas-coke as fuel, the room is thoroughly dried out, and afterwards whitewashed and renovated.

The boxes in which the fish are ultimately shipped cost 35 cents, and 2 cents additional for making. All the boxes which go to Chicago are returned, except when a dealer has some special reason for wishing to retain them.

Most of the fish are frozen round, but the trout are always cleaned, as they spoil if the viscera are allowed to remain in them. The sturgeon are always dressed, but the skin is left on; the fishermen are required to remove the heads, collar bones, fins, and tails before they are accepted by the buyer. The dories find their way mostly to the Jewish trade, which requires them in a round state.

Dories and perch and some black bass begin to be put in the freezer the first of the spring, and are followed by sturgeon and No. 2 whitefish in June, July, and August. Towards the end of October round whitefish and all the common species find their way to the freezer.

The period of time during which the fish remain in the freezer varies considerably. Sturgeon are frequently allowed to remain for a whole year, but other fish as a rule are only held for four or five months, although it has happened that whitefish have been kept for nineteen months. The sturgeon are smoked in Chicago before being placed upon the market.

Statistics of frozen fish.—In 1884 there were frozen 196,941 pounds of No. 1 whitefish, 78,101 pounds of No. 2 whitefish, 67,890 pounds of trout, 93,079 pounds of dories, 6,449 pounds of bass, 17,958 pounds of perch, 71,475 pounds of herring, and 27,769 pounds of sturgeon, making a total of 559,622 pounds, all of which were frozen round, with the exception of the sturgeon, the trout, and 51,743 pounds of No. 1 whitefish.

In 1885 the quantity was much smaller, amounting to only 26,003 pounds of No. 1 round whitefish, 19,443 pounds of No. 2 round whitefish, 27,107 pounds of dressed whitefish, 165,835 pounds of dressed trout, 20,763 pounds of dories, 3,073 pounds of bass, 18,869 pounds of perch, 100,114 pounds of herring, and 36,432 pounds of dressed sturgeon. It

will be noticed that the great decrease in all other species has been accompanied by an increase in the quantity of trout, herring, and sturgeon.

Statistics of fish trade.—Besides the fish collected by the steamers there were purchased in 1884 by the Escanaba house of A. Booth & Sons 150,038 pounds of No. 1 whitefish, 38,156 pounds of No. 2 whitefish, 35,806 pounds of trout, 131,010 pounds of dories, 9,349 pounds of bass, 23,223 pounds of perch, 381 pounds of herring, and 32,977 pounds of sturgeon. The usual prices paid are 4 cents a pound for No. 1 whitefish, 1½ cents for No. 2 whitefish, 2½ cents for trout, sturgeon, and dories, 1 cent for herring and perch, and 5 cents for bass.

The total purchases in 1884 and 1885 are shown in the following tables:

Fish purchased from fishermen by a firm at Escanaba, Michigan, in 1884.

Month.	White-fish.	Trout.	Dories.	Sturgeon.	Herring.	Bass.	Perch.	Total.
January	4, 748	....	....	....	....	....	....	4, 748
February	734	253	88	....	....	....	....	1, 075
March	1, 954	1, 204	....	....	381	....	....	3, 539
April	2, 250	5, 842	10, 366	72	....	....	267	18, 797
May	67, 433	81, 532	73, 575	6, 193	....	6, 158	19, 539	254, 430
June	58, 526	35, 906	21, 922	25, 687	....	2, 713	[1]1, 935	146, 689
July	30, 456	7, 142	11, 440	2, 673	875	39	217	52, 842
August	99, 111	1, 548	803	2, 209	....	44	70	103, 785
September	26, 400	3, 180	5, 641	1, 312	....	325	329	37, 187
October	96, 235	23, 036	9, 933	2, 311	2, 797	120	507	134, 939
November	71, 893	13, 887	5, 156	194	3, 567	....	690	95, 387
December	22, 867	....	....	....	....	....	....	22, 867
Total	[2]482, 607	173, 530	138, 924	40, 651	7, 620	9, 399	23, 554	876, 285

[1] Including 331 pounds of bull-heads.
[2] Including 112,786 pounds of No. 2 bought between August and December.

Fish purchased from fishermen by a firm at Escanaba, Michigan, in 1885, excluding those brought from Manistique.

Species.	Pounds.	Value to fishermen.
Whitefish, No. 1	223, 648	$8, 945
Whitefish, No. 2	27, 988	420
Trout	97, 259	2, 432
Dories	82, 284	2, 057
Sturgeon	51, 604	1, 290
Herring	70, 290	703
Bass	8, 451	423
Perch	33, 900	339
Total	595, 424	16, 610

Shipments.—Nearly all of the fish handled are shipped to the firm's central house at Chicago. The following table shows the monthly shipments of fresh and frozen fish in 1884. These fish were not all, however, the product of the fisheries of Green Bay and its tributary and adjacent waters, for a portion of them were brought to Escanaba from the house at Manistique for shipment:

Shipments of fresh and frozen fish in 1884 *by a firm at Escanaba.*

Month.	White-fish.	Trout.	Sturgeon.	Bass.	Dories.	Perch.	Miscellaneous.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
April	9,000	14,000	....	....	11,000	....	....	34,000
May	61,000	85,000	2,000	3,000	20,000	4,000	....	175,000
June	70,000	50,000	14,000	....	10,000	....	....	144,000
July	103,000	59,000	13,000	....	8,000	....	....	183,000
August	91,000	17,000	21,000	1,000	7,000	....	7,000	144,000
September	42,000	34,000	2,000	2,000	8,000	....	1,000	89,000
October	69,000	29,000	4,000	3,000	8,000	....	....	113,000
November	30,000	4,000	....	....	2,000	....	....	36,000
December	67,000	....	....	....	24,000	....	....	91,000
Total	542,000	292,000	56,000	9,000	98,000	4,000	8,000	1,009,000

Description of shipping cars.—The cars used in shipping the fish consist of a box mounted on a four-wheeled iron truck and having an iron tongue at one end. The larger size employed is 6 feet 4 inches long, 40 inches wide, and 3 to 3½ feet deep, inside measurement, with wheels 1 foot in diameter. The walls are made double, of matched seven-eighths-inch boards, with an intervening space of about 2 inches containing packing material. The small fish cars are 55 inches long, 29 inches wide, and 28 inches deep, with walls 3 inches thick and wheels 9 inches in diameter. The quota of fish to each large car in warm weather is 1,800 pounds, and in cold weather 2,000 pounds. The small cars have a capacity of about 800 pounds.

Other notes on trade.—In addition to the fresh fish handled in 1884 there were salted about one hundred packages of whitefish and the same quantity of trout. There is also at Escanaba a local dealer who drives along the shore, between Misery Bay and the city, and buys fresh fish to the amount of 600 or 700 pounds a week. The fishermen ship their own salt fish by steamer.

Statistics.—The number of men employed in the fisheries in 1885 was 84, in addition to 9 men at work on shore in receiving and preparing the products. One steamer was employed regularly in collecting fish, and 6 gill-net boats, 8 pound-net boats, and 16 scows and small boats were used in the fisheries. Nine hundred and thirty-five gill-nets, 37 pound-nets, 9 haul-seines, and several fyke-nets were fished. The total value of floating property was $11,021, that of the apparatus of capture was $7,030, and that of shore property, including cash capital, $44,710. The products consisted of 401,494 pounds of fresh and frozen fish, 118,800 pounds of salted fish, and 520,294 pounds of smoked fish; the total value, including caviare and isinglass, amounting to $34,948.

Gill-net fishery.—Several years ago there were nearly twenty gill-nets between Peninsula Point and the dividing line of Delta and Menominee Counties. At that time fish were so plenty that one of the fishermen with a sail-boat claims to have caught $5,000 worth of fish in a single season about 1881. A diminished productiveness has caused this branch of the business to decline, and there are now within the same limits not more than half a dozen crews. They make their head-

quarters at Escanaba, but carry on their fishing from Peninsula Point and Bark River.

The catch is largest in the spring and fall. The fishing begins as soon as the ice is out. At first the nets are fished in the bay, but, as the summer comes on and the whitefish go into the deeper water, the fishermen follow them, and fish in the lake from July till October or November, when the open water becomes too rough, and then return to the bay fishing. In August they usually lay up, and most of them do so in July as well, as the catch is always small in those months. Several of the crews conclude their season's work some time in October. It occasionally happens that nets are left on the fishing-grounds all winter, but this reprehensible practice calls forth strong protestations from the pound-net and other fishermen, as it results in the useless destruction of many fish which become caught in the meshes of the unvisited nets and pollute the water by their decay.

During the months of May, June, and July, 1884, the steamer *Hahn* fished with gill-nets for the Escanaba market, having a total catch of 6,841 pounds of whitefish, and 24,309 pounds of trout. There was no steamer fishing in 1885.

The gill-nets used were about 45 fathoms long with a mesh of from $4\frac{1}{4}$ to $4\frac{3}{4}$ inches. In 1882 a $3\frac{3}{4}$-inch mesh was used. About half of the nets are rigged with cork and lead, and the rest still retain the float and stone. They are lifted three or four times a week. The boats are mackinaws with fixed bowsprits and are worth from $175 to $320, averaging $250. A typical specimen of these, the *Jennie Gilbert*, of Escanaba, is described on page 22 of this report.

The catch in 1884 would average about 200 pounds to each lift. Nearly one-half of the entire quantity was salted, and the remainder sold mostly to Booth in the fall, though in the spring that firm does not get over a quarter of the fresh fish.

Pound-net fishery.—The fishing with pound-nets is well distributed in the Little Bay de Noquet and along the neighboring shores of Delta County below Escanaba, but the two most important groups of nets are found near Peninsula Point, directly opposite to the city, and southward in the vicinity of Indiantown and Bark River.

The nets vary from 14 to 47 feet in depth, averaging about 30 feet. Parties on St. Martin's Island once tried the experiment of setting a pound-net 100 feet deep, but it has not been fished for several years. In 1883 a net 65 feet deep was tried, but it did not prove a success, and was cut up into shallower nets. On the broad shoals below Escanaba and around the mouth of Cedar River fishermen are in the habit of setting nets of only 14 or 16 feet, which, although sometimes fished for other species, are usually designated in the vicinity as sturgeon nets.

Pound-nets are occasionally fished continuously from spring until late fall, as long as the water is open. The most sagacious men, however, pull them up for six weeks, from the first of August to the middle of

September. When the water is warm the wear and tear upon the nets is greater than at other seasons, and the fish are comparatively scarce and are difficult to preserve. The nets are generally tarred every spring, before the beginning of the season. They should be tarred annually, but in some cases the fishermen think this is not necessary, and it is therefore omitted. At occasional intervals one net at a time is taken out and washed, and then replaced in the water. Some of the nets are fished by the owners or on shares, but the men who fish Booth's nets receive regular wages of $30 per month.

In spring the principal species taken are those comprised under the term of coarse fish—that is to say, pike, pickerel, dories, and perch, with a very few bass. In the fall the catch is very much mixed. Both dories (*i. e.*, pike and pickerel) and sturgeon are more numerous than in Big Bay de Noquet. This is especially true of the former, as the sturgeon are abundant at the extreme head of the Big Bay.

The following table shows the catch of ten pound-nets in 1884. This may be taken as a fair average of the pound-net fisheries of the region:

Month.	Whitefish.	Trout.	Dories.	Sturgeon.	Herring.	Perch.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
May	2, 182	492	4, 077	2, 466	1, 055		10, 272
June	6, 033	700	5, 065	4, 209	180		16, 187
July	9, 080		5, 209	1, 016	300	400	16, 005
August	12, 572		4, 735	815			18, 122
September	4, 345		3, 275	1, 030	150		8, 800
October	23, 195		8, 205	1, 785	4, 870		38, 055
November	7, 985		290		18, 420		26, 695
December	1, 905				17, 617		19, 522
Total	67, 297	1, 192	30, 856	11, 321	42, 592	400	153, 658

The monthly stock of eight pound-nets near Peninsula Point, in 1884, was as follows:

May	$283. 44
June	333. 04
July	46. 49
September 1 to October 14	343. 06
October 14 to 31	408. 69
November 1 to 22	102. 84
Total	1,517. 56

In addition to the above, which represents only the fresh fish taken, 40,000 pounds of herring from the eight pounds were salted.

Haul-seine fishery.—Nine haul-seines are fished in the region under consideration. Three men constitute a crew. The fishing is limited to the spring, reaching its height during the six weeks from May 4 to June 10. Formerly there was a profitable seine fishery in the fall, but it has been entirely discontinued. Seining has never been carried on to any considerable extent in summer. The fifteen Masonville seine-fishermen engage in entirely different work at other seasons of the year, but four seines are fished on shares by the pound and gill-net fishermen. The

seines used are about 495 feet in length and are worth $150 each. About two-thirds of the catch consists of pike and pickerel, and the rest mostly of perch. The entire yield is sold fresh at 2 cents a pound for the dories and 1 cent for the perch.

The following table shows the catch of three seines in 1884:

Month.	Whitefish.	Dories.	Sturgeon.	Bass.	Perch.	Bull-heads.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
April	102	1,197				97	1,396
May	120	1,812	15	825	482		3,254
June		1,311	64	55	16		1,446
July		1,083		27			1,110
Total	222	5,403	79	907	498	97	7,206

Ice-fishing.—There is some spearing through the ice, but the principal fishery carried on during the winter is that with gill-nets. There are twelve crews, of two men each, in Little Bay de Noquet, fishing in that manner. Four of the crews have sixty nets each, and the others from six to thirty nets. Their fishing usually begins just after Christmas and lasts for four or five weeks. Each fisherman takes a little shanty with him on the ice for protection while fishing. If fishing is good, almost every man in the vicinity will put a net in, and it is claimed that the number of nets in the water frightens away the fish, so that they leave earlier than would otherwise be the case. At any rate, by the first of February it is found no longer profitable to keep the nets in the water, and the last of them are soon taken up. The average catch is 5 tons to each crew, consisting of whitefish and trout in the proportion of three to one. During the height of the fishing the average catch would amount to about 2,000 pounds a week. There are several fishermen, one of them living at Misery Bay, who fish 3-inch nets for ciscoes during the same season and in the same manner.

Other fisheries.—There is no other fishing in the Little Bay de Noquet and its vicinity, with the exception of a few fyke-nets used by one of the residents of Masonville.

38. MENOMINEE COUNTY, MICHIGAN.

Geography.—Delta County, which encircles the northern end of Green Bay, extends down the shore to a point about 9 miles south of Bark River. Menominee County includes the remainder of the shore to Menominee River, which forms the southern boundary of this portion of the State. Cedar River, the only other stream of any importance, is about 7 miles below the Delta County line.

The beach is uniformly shelving and the depth increases very gradually, not reaching the four-fathom line until more than a mile from the shore. The bottom is of sand and clay and furnishes a firm support for pound-net stakes.

Inhabitants.—The city of Menominee is the only important place on

the shores of this county. There was formerly quite a settlement at the mouth of Cedar River, with a saw-mill, store, and hotel, but at present five or six families of fishermen constitute the entire population. A few more fishermen live near by in a locality known as Little Cedar.

About 8 miles below Cedar River is the hamlet of Leatham, where there is a single saw-mill, which is operated only in the winter, and a few families of fishermen. Another fishing hamlet is Dennis, a few miles further south, which, like the others, contains only about half a dozen families. There is little or no farming, and the lumber and fishing industries divide the attention of the people.

Character of the fisheries.—The fisheries are at present carried on almost wholly with pound-nets owned by men living along the shore and at the little places just enumerated. The gill-net fisheries, which were formerly of equal importance, have dwindled down to a few small gangs of nets fished by the pound-net men in the intervals of their other work. There is only a little ice-fishing.

Fishermen.—Most of the fishermen make their living during the winter by wood-cutting. They are of different nationalities, including Scotch, Irish, Poles, Germans, and Scandinavians, the two last named predominating. There are no Indians or half-breeds among the number.

Trade.—The principal dealer goes along the shore with a team and buys both fresh and salt fish. He was the only man handling fresh fish in 1884, though one of the pound-net fishermen collected a few hundred dollars' worth with the steam-barge *Myra* in September, 1885, and a few fish annually are sold fresh at Menekaunee, just over the Wisconsin line.

The quantity of fish sold fresh was comparatively small. There were two other smaller firms dealing in salt fish in 1884, and three in 1885, though the additional one in the latter year handled only the products of the fisheries of 1884 which had been held through the winter for the sake of better prices. An interesting feature of the salt-fish trade of 1884 was the salting of a number of barrels of yellow perch, a species which had hitherto invariably been sold fresh. The town of Menominee is supplied mostly by the fishermen themselves and by peddlers, the dealers giving their attention to the shipping trade.

The following table shows the quantity of fish handled by the dealers of Menominee County in 1884. It should be borne in mind that these fish were not all the product of the fisheries of that year, as large quantities had been salted and kept over from the preceding season by the fishermen, according to the common custom of the region:

How sold.	Whitefish.	Trout.	Dories.	Sturgeon.	Herring.	Perch and suckers.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fresh	29, 200	9, 300	8, 500	7, 000	45, 000	1, 000	100, 000
Salt	162, 500	78, 750	16, 250	....	437, 500	5, 000	700, 000
Total	191, 700	88, 050	24, 750	7, 000	482, 500	6, 000	800, 000

The fishermen occasionally ship their salt fish from Menominee themselves, and they sometimes sell at Fairport (Bay de Noquet), or to one of the firms at the city of Green Bay. Sturgeon are never salted; when there is no buyer at hand, they are thrown back into the pot of the pound-net or put into a pen near the shore. Sometimes they are kept inclosed in a little creek for two or three weeks before being sold. The fishermen have not yet begun to smoke any variety of fish, and that art is yet unknown in the entire region.

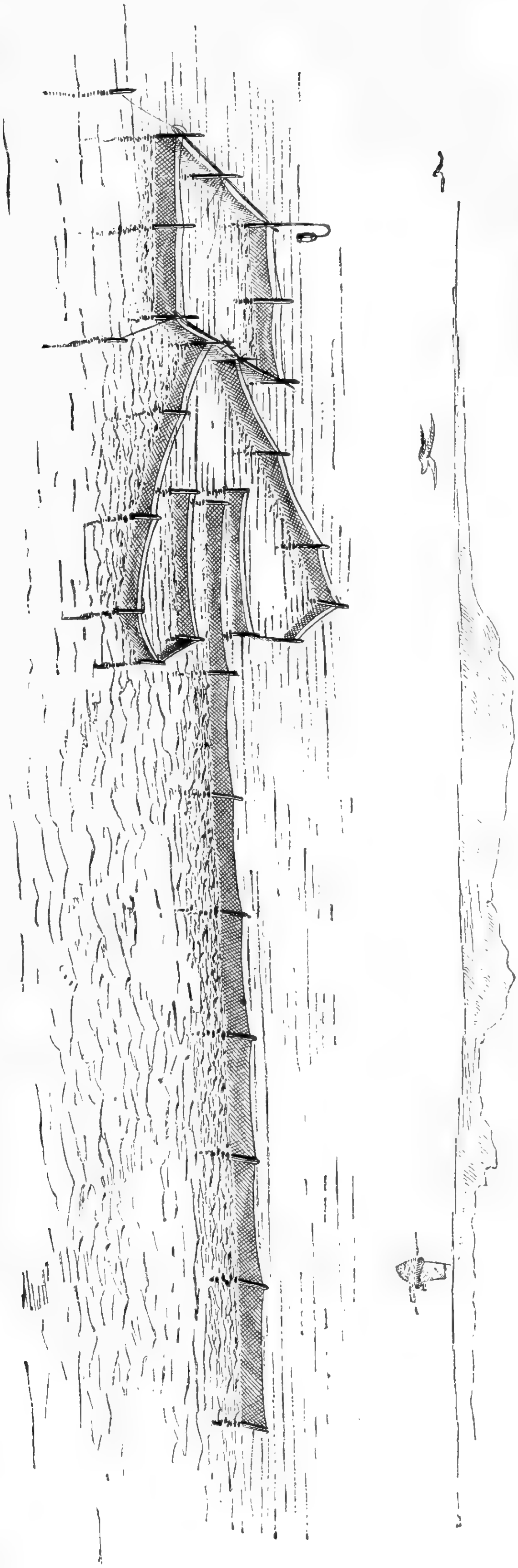
Prices.—In 1884 the prices received by the fishermen for salt herring varied from $1 to $2 per barrel, averaging $1.40. Number 1 whitefish brought $4.50 per barrel and No. 2 less than $3, making the general average for whitefish about $4. Trout sold for from $2 to $3, averaging $2.50. Dories brought $2 and suckers $1.25.

The barrels used cost 45 cents apiece. They are made by individual coopers, one of whom resides at Menominee, one at Dennis, two at Leatbam, and three at Cedar River. About 1,000 barrels are made annually at the last-named locality and 500 at each of the others. A barrel of salt, sufficient for preparing about twelve barrels of fish, could be bought for $1.65.

Statistics.—The fisheries of Menominee County gave employment in 1885 to 50 fishermen and 6 shoresmen. There were used in the fisheries a collecting tug, 18 pound-net boats, and 23 other boats. The apparatus of capture were 215 gill-nets and 42 pound-nets. The value of floating property was $5,440; of pound-nets and gill-nets, $15,000; of buildings, $3,275; of accessories, $3,075; and of cash capital, $8,100. The products amounted to 21,500 pounds of fresh whitefish, 64,800 pounds of salt whitefish, 7,000 pounds of fresh trout, 23,700 pounds of salt trout, 5,200 pounds of fresh pike, 8,000 pounds of salt pike, 7,209 pounds of sturgeon, 21,900 pounds of fresh herring, 779,600 pounds of salt herring, 1,000 pounds of miscellaneous fresh fish, and 15,000 pounds of miscellaneous salt fish, the whole having a value of $15,290.

Pound-net fishery.—The first pound-net in the county is said to have been set near Menominee in 1858, but the fishery did not begin to be important until the year 1867. More pound-nets were set in the waters of Menominee County in 1884 than at any time since the beginning of the fishery. In that year there were twenty crews, containing 58 men, who employed 46 nets, worth $15,000, and 34 boats and 17 pile-drivers, aggregating $2,150; but in 1885 the number had fallen off to 15 crews, aggregating 48 men, with 42 nets, worth $13,900, and floating property to the amount of $2,840. The shore property and other capital amounted in 1884 to $10,000, and in 1885 to $8,850.

The nets have a mesh of 2 to $2\frac{3}{4}$ inches in the pot, and are set in water from 6 to 60 feet in depth, averaging 20 or 25 feet. The shortest are the ones set near the shore for sturgeon. A pound-net of ordinary dimensions will have a pot 20 to 38 feet square, a heart 115 to 150 feet long, and a leader about 1,000 feet long. The mesh of the hearts is



GREEN BAY POUND-NET.

Drawn by L. Kumlien.

usually about 4 inches, and of the leaders 6 inches. All the nets have short funnels about 18 feet long. The cost of a new net is about $500, but the average value for all that are in use in the region would be about $300 each as they stand.

Each crew contains from 2 to 6 men, who, in addition to their board during the fishing season, usually receive $25 a month in the summer, which is increased to $30 or $35 in the fall, when the profits become greater.

The season begins shortly after the ice goes out, usually about the middle of May or the 1st of June. Between the 25th and 30th of July the nets are usually taken out to be washed, and, if the prospects are promising, are put back as soon as they have been mended and tarred; otherwise they are kept out until some time in September, from which date they remain in use until the latter part of November, when the water freezes. There have been no experiments in pound-net fishing under the ice. Some of the crews pull their stakes up in the fall by means of a windlass mounted on a small scow; but more frequently, when there are woods near by, they are allowed to remain to be carried away by the ice, and are replaced by new ones in the spring. In some cases they cost $2 or $3 apiece. With rare exceptions each pound-net firm has a scow pile-driver, and in two instances the latter is operated by steam.

The proportions of the species taken have varied considerably at different times in the history of the industry, though the same style of net has been in use since the early stages of the business. In 1873 half of the catch was whitefish and most of the remainder herring, with very few trout. At that time the fishing was more profitable than at present. In the spring of 1871 there were obtained from two nets 400 packages of whitefish and 50 packages of other fish; and in fall of the same year 160 packages of whitefish, 120 packages of herring, and 30 of trout. The whitefish began to decrease in abundance about 1877, and are now comparatively scarce. In 1881 there were obtained from three nets 525 packages of Nos. 1 and 2 whitefish, 175 packages of No. 3 whitefish, and 250 packages of herring and trout. The whitefish are claimed to have left suddenly in the summer, and this is said to have been the result of the sawdust brought down in great quantities from the mills on the Menominee River.

The brief table following shows the catch of five pound-nets belonging to a crew fishing about six miles north of Menominee in 1884:

Season.	Whitefish.	Trout.	Herring.	Suckers.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Spring	300	400	30,000	2,000	32,700
Fall	400	300	40,000		40,700
Total	700	700	70,000	2,000	73,400

For some years the fishing between Cedar River and Menominee has yielded unusually small results, and to this cause must be attributed the serious falling off in the extent of the fishing during 1885.

The value of the products of the pound-net fishery in 1884 was $29,930, and in 1885, $15,201. The catch was divided as shown in the following table:

Species.	1884.			1885.		
	Fresh.	Salt.	Total.	Fresh.	Salt.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Whitefish	30, 000	140, 000	170, 000	20, 000	64, 800	84, 800
Trout	10, 000	45, 000	55, 000	7, 000	23, 700	30, 700
Dories	10, 000	34, 500	44, 500	5, 200	8, 000	13, 200
Sturgeon	8, 000	....	8, 000	7, 209	....	7, 209
Herring	50, 000	1, 070, 000	1, 120, 000	21, 900	780, 600	802, 500
Perch and suckers	3, 000	5, 100	8, 100	2, 000	3, 400	5, 400
Total	111, 000	1, 294, 600	1, 405, 600	63, 309	880, 500	943, 809

The 648 packages of whitefish put up in 1885 were divided as follows among the different grades: 120 packages No. 1, 85 packages No. 2, 120 packages No. 3, and 323 packages No. 4.

Gill-net fishery.—Gill-nets were formerly used very extensively in the fisheries between Cedar River and Menominee, and for a long time most of the fishermen divided their time between the gill-net and pound-net fisheries. In 1875 there were twenty crews, with two men each, fishing for whitefish in this way, and they did well, their profits averaging $250 to $400 a season to each man. The water remained open in the winters of 1878, 1879, and 1880, and the gill-net fishery rapidly fell off until now there are but four crews, who fish rather irregularly, with 165 nets, during the season of the pound-net fishing, to which they give their principal attention. The nets are 16 fathoms long and 40 meshes deep, with a mesh of 2¼ to 2½ inches. Their catch in 1884 amounted to 2 tons of whitefish and trout, and as many as 10 tons of herring.

Ice fishing.—The gill-net fishing through the ice has dwindled down to one crew of two men, who fish about fifty nets of 50 fathoms each, with a 4½- and 5 inch mesh. Their catch in 1884 consisted of 1,500 pounds of whitefish.

There was formerly an extensive fishery with hand-lines. In 1880 there were twenty men engaged in bobbing through the ice. They received 7 cents a pound for their fish and earned on an average about $50 apiece every month. In the winter of 1884–'5 only two or three men occupied themselves in this way.

Other fisheries.—Twenty years ago a few seines were fished in the region, but this fishery has become entirely extinct. No fyke-nets or set-lines are used.

39. MARINETTE COUNTY, WISCONSIN.

Importance of the fisheries.—That part of the shore of Green Bay which extends from the Menominee River to Green Bay City, at the head of the bay, is one of the most important fishing centers of Lake Michigan. It is flanked along its whole length by shoals of 5 to 18 feet in depth, which extend from 2 to 5 miles from the land and furnish an opportunity for the setting of pound-nets in almost unlimited numbers.

Rivers and settlements.—Besides numerous small streams, this region is watered by the Peshtigo, Oconto, Pensaukee, Little Suamico, Big Suamico, Duck, and Fox Rivers. Marinette County includes only the Menominee and Peshtigo. Peshtigo Point, just above the mouth of the Peshtigo River, is continued into a narrow sand shoal reaching out nearly 5 miles towards the mouth of Sturgeon Bay, which is directly opposite.

The town of Menekaunee, at the mouth of the Menominee River, is the only place of importance on the bay shore, though Marinette, the county seat, is not far distant, and Peshtigo River possesses a town of the same name about 12 miles above its mouth.

Character of fisheries.—The principal fisheries are with gill-nets through the ice for whitefish, trout, and herring, but the pound-net fishing is also extensive, and there is some "bobbing" in winter.

Trade.—The only dealer of note is at Menekaunee. He handles the greater part of the products, both fresh and salt, of the section under consideration, besides buying a good many fish from the fishermen of other portions of Green Bay. Formerly he used a tug in collecting fish during the summer months, but it was sold in 1884 and none has been running during the present year.

The following table shows the extent of the fish trade of Menekaunee during the years 1884 and 1885:

Species.	1884.			1885.		
	Fresh.	Salt.	Total.	Fresh.	Salt.	Total.
	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.	Pounds.
Whitefish	110,000	150,000	260,000	80,530	50,000	130,530
Trout	40,000	10,000	50,000	75,920	15,000	90,920
Pike	2,500	2,000	4,500	10,036	....	10,036
Sturgeon	7,500	....	7,500	24,296	....	24,296
Herring	230,000	12,000	242,000	134,381	40,000	174,381
Black bass } Bullheads } Perch } Suckers }	10,000	....	10,000			
Black bass				3,145	....	3,145
Bullheads				1,427	....	1,427
Perch				8,442	....	8,442
Suckers				5,561	....	5,561
Total	400,000	174,000	574,000	343,738	105,000	448,738
Value of same	$11,642	$7,140	$18,782	$10,192	$3,542	$13,734

Statistics.—The total number of persons employed in the fisheries of Marinette County in 1885, including the dealer, was fifty-six, representing a dependent population of about 125. Nine gill-net boats, six

pound-net boats, and 10 other boats, had a combined value of $2,070. There were used 866 gill-nets, worth $3,410, and 14 pound-nets, worth $3,800, besides two haul-seines and three fyke-nets, the total value of the apparatus of capture amounting to $7,685. The cash capital and the value of the shore property and accessories amounted to $7,480.

The products in the same year were 77,500 pounds of fresh whitefish, 58,000 pounds of salt whitefish, 7,500 pounds of trout, 27,000 pounds of pike and pickerel, 50,000 pounds of fresh sturgeon, 5,000 pounds of salt sturgeon, 220,000 pounds of fresh herring, 100,000 pounds of salt herring, and 7,000 pounds of other fish, mostly bass and perch. The value of the products to the fishermen was $15,540.

Pound-net fishery.—The pound-nets of Marinette County are similar to those of the adjoining shores of Michigan. They are owned mostly by residents of Menekaunee and are set singly or in pairs at regular intervals along the coast between that place and Peshtigo Point. During 1885 five crews were employed in this fishery, and their pound-nets numbered ten, fished principally for herring, and three for sturgeon. During the previous season (1884) the same men had fished a total of eighteen pound-nets. The products of this fishery in that year are shown in the following table:

How sold.	Whitefish.	Pike.	Sturgeon.	Herring.	Total.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Fresh	11,428	3,335	42,857	....	57,620	$2,000
Salted	75,000	....	9,000	117,600	201,600	4,649
Total	86,428	3,335	51,857	117,600	259,220	6,649

Whitefish gill-net fishery.—There are nine crews who fish for whitefish and trout with 45-fathom gill-nets from January 10 to the end of June. As long as the water is frozen over they work through the ice in a manner similar to that of the herring fishermen. After the breaking up of the ice they continue for two months in the open water. During the ice fishing they shelter themselves with shanties 12 feet long and 10 feet wide, made of boards and costing about $15. Some of them have a stove also, costing from $3 to $8. Each crew makes on an average from $200 to $250 a season in the ice fishing and $500 while fishing in open water. One-tenth of the catch is trout and the rest whitefish. The fish are sold fresh at from 6 to 8 cents per pound.

Herring gill-net fishery.—In the winter of 1882–'83 two men who had come to Menekaunee from Green Bay City began to fish small-meshed gill-nets through the ice for herring, a practice which had been carried on for several seasons by a few fishermen at their former homes. They did fairly well that season, and others followed their example, so that in 1883–'84 there were six crews, and in 1884–'85 over a dozen, and there seems to be a tendency on the part of the inhabitants of Menekaunee to go into it still more extensively in the future.

The nets used in this fishery are 14 fathoms long and about 42 meshes, or 6 feet, deep, with a 2¼-inch mesh, except in the case of one crew who use a mesh of 2½ inches. The floats are made of cork and are not quite sufficiently buoyant to keep the net exactly at the surface, as in that case it would freeze fast to the ice. Formerly lead sinkers were in vogue, but they have been replaced by little bags of sand which do not become entangled in the webbing as the leads generally do. Twenty-two nets constitute a gang, and about that number are usually fished in a string, though the quantity owned by the individual fisherman varies from six to twenty-five nets, averaging only about fifteen.

The fishing begins in the fall as soon as the ice is strong enough to admit of it, which is usually between Christmas and New Year, but is very seldom delayed till the latter date. It lasts as long as the ice remains firm and closes about the middle of March.

The men go out a couple of miles from the shore. The depth of the water in which they fish varies considerably. One crew had the inner end of their string of nets in 12 feet of water, and the outside end in 18 or 20 feet, but most of the nets were set in water about 10 fathoms deep. The run of fish is more steady and uniform in the deeper water, but when they do come in to shallow water they are more numerous than at a greater depth.

Four or five holes about 2 feet in diameter are cut in the ice, which is usually 3½ to 4 feet thick, and these are alternated with an equal number of only half that size. Two nets are set from each hole, one running one way and one the other. The holes are made square, but are apt to freeze into a circular shape. The small ones are allowed to remain round, but the large ones are kept square by cutting out the corners at frequent intervals. A string is run under the ice from one hole to the other by means of a long pole. The nets are then placed in position and a small cord attached to each, by means of which it may be pulled up. A forked stick is cut in the woods, the principal arm of which is 3 or 4 feet long. This crotch hangs down in the middle of the hole and to it the net is fastened. The net is intended to be stretched tight and is suspended at both ends. It is never set on the bottom, though sometimes the middle of it sags a little and touches the bottom when set in shoal water. Occasionally on account of too buoyant floats the net is frozen fast to the ice, which must be chopped away in order to release it.

As a shelter, while setting and pulling the nets, the fishermen use a shanty 5 feet long and 4½ feet wide, costing \$5 to \$7. It has a hole a foot and a half square in the bottom, and contains a little sheet-iron stove. This shanty is moved from hole to hole, according to the convenience of the owners. Sometimes, instead of a shanty, a canvas slide is used, 6 by 8 feet square and 5 feet high, worth about \$3.

Each man carries his nets to the fishing-ground on a hand-sled upon which, after the fishing is over, he brings his catch back to town. The

sled is about 2 feet wide and 5 feet long, with oak runners 5 or 6 inches wide and 2 or 3 inches thick, shod with iron. It is surmounted by a box, and when a large quantity of fish has been obtained, additional boards are placed so as to project at the sides and increase the carrying capacity of the vehicle. In most cases the sled has a mast and sail, by which it can be transformed into an ice-boat when the wind is favorable.

The nets are lifted twice a day, and the fish, as they are removed from the meshes, are thrown upon the ice, where they are frozen solid in a very few minutes. They are almost entirely herring, with only occasionally a perch or trout. Great care is taken to protect them from the gulls, which are always on the alert to provide themselves with a meal at the fishermen's expense. If, while the fish are lying on the ice, a line, or a row of sticks, is placed around them, the birds do not dare to approach. Towards spring the fish are often shipped without being frozen. In that case they are packed in snow to keep them from being touched by the frost while in transit.

As many as 450 or 500 pounds have been taken at one lift, but that is an exceptional case. The most successful fisherman in the winter of 1883–'84 obtained $400 worth, from sixteen nets, selling his fish at 3 cents per pound. The average quantity of herring per man marketed in the season of 1884–'85 was about 4 tons, and the price received did not average over 1¾ cents a pound. The herring weighed only a third of a pound apiece. On account of the decreased demand and fall in prices, caused by the freezing of a great many spoiled herring in the fall of 1884, a considerable part of the catch was left on the ice and devoured by the gulls. One of the Menominee dealers sometimes comes in a wagon to buy the fish, but they are usually brought in by the fishermen on their sleds and sold to the firm at Menekaunee. When the prices are very low a good many of the fishermen peddle their catch around the town.

"Bobbing" through the ice.—Thirty years ago a considerable portion of the inhabitants of this and surrounding regions made a practice of trout-fishing through the ice every winter, with hook and line. Twenty-five years ago the number engaged in this fishery was still large. At that time it was customary to spend the winter on the fishing-ground. Three or four men usually lived in a shanty about 12 feet long and 10 feet wide set on runners. The shanties were built on shore and hauled out by teams hired for the purpose to the place selected for the season's quarters, which was usually 5 or 6 miles from the shore and over water 16 or 18 fathoms deep. It was not uncommon for twelve or fifteen of these shanties to be seen in one group. Two herring-nets were usually owned by the crew of the shanty, and were set for herring to be used as bait upon the hand-lines. Six or seven baits may be obtained from one herring. The fins and tails were used with the rest, and frequently the heads also. Sometimes the trout bite the heads better than any other part of the herring, but at other times the fisherman has to sub-

stitute a piece of the soft portion of the fish in order to have any success. Each man fished independently, but took a sled with him and set its mast and sail up on the ice as a wind-break. The wind-screen consisted of 8 or 10 pounds of canvas, with poles at the top and bottom, like the sail of a square rigged vessel. The line was kept 8 or 10 inches from the bottom, and when trout were plenty the fisherman would sit and bob away steadily all the time. The fisherman stuck his ice-cutter into the ice and tied his sled to it, cutting grooves in the ice for its runners to stand in, lest it should be blown away and lost. When he felt a fish biting the bait, he jerked the line, threw it over his shoulder and ran with it. As trout take the bait very gently, a man who is not an adept frequently does not notice the slight movement and fails to secure the fish. Considerable skill is required also in hauling in the line. If it is pulled too tight the hook will tear out of the fish, and if too loose the fish will disengage itself from the hook. The result was that those who were accustomed to this mode of fishing would make $2 or $3 a day when others would be glad to get even one dollar.

In those days when the fishing was good a number of men made a business of going out with teams and buying the fish. Menekaunee was the principal place for the trout-bobbing, though there was some from Green Bay City. The best fishing-ground is east of Ellison Bay, at Port des Morts, or Death's Door. Notwithstanding the abundance of the fish at that point it is open to the serious objection that it is one of the channels by which Green Bay communicates with the open waters of Lake Michigan, so that the ice breaks up frequently, and there is consequently considerable danger of accidents and even loss of life.

Haul-seine fishery.—There is very little fishing of any description outside of the kinds already mentioned. There are, however, two haul-seines in the county, with a crew of two men each, one valued at $250 and the other at $150. They are used irregularly in summer for the capture of pike and perch, of which about two hundred dollars' worth are taken in a season by the two seines. No whitefish or herring are obtained.

Fyke-net fishery.—Three fyke-nets are owned on this shore, which are fished from spring till the middle of October, for pike, bass, and pickerel. Their catch amounts to about $1.50 per day.

40. OCONTO COUNTY, WISCONSIN.

General remarks.—The shore-line of this county is about 30 miles in extent. It is somewhat undulating in character, and is broken by the mouths of three rivers—the Oconto, Pensaukee, and Little Suamico—on which are located the three towns which bear their names. The majority of the inhabitants of the region are dependent for a livelihood upon the lumber industry. The fisheries rank second in importance. The facilities for water shipment are good, the Chicago and Northwestern Rail-

way traverses the shores, and all the important towns have express and telegraphic connections.

Oconto.—Oconto, the county seat, is on Green Bay, at the mouth of the river. It is one of the principal lumber manufacturing towns of the State, and has also flour-mills, wagon-factories, and foundries. It has a population of 4,500, of whom at least 200 are dependent on the fisheries. There are about 15 pound-net crews and 14 crews of winter gill-net fishermen, many of the men taking part in both fisheries.

Pensaukee.—Pensaukee is 6 miles south of Oconto, at the mouth of the Pensaukee River. It has large shipments of shingles, posts, ties, baled sawdust, and other products of the lumber industry, and is the home of 4 crews of fishermen who give their principal attention to pound-nets, but operate gill-nets, fykes, or seines during their intervals of leisure.

Little Suamico.—Little Suamico, on the Little Suamico River, is the location of a number of large saw-mills and is an important shipping point for grain. It has a population of 600, nearly one-eighth of whom are dependent upon the fisheries. There are four pound-net crews, and a little seine, fyke-net, and gill-net fishing.

The pound-net fishery is by far the most important of the fishing industries of the county. It is carried on, with a few weeks intermission in summer, throughout the period of open water. In the winter months many of the pound-net fishermen and some others fish through the ice with gill-nets for whitefish and herring. The fyke-net and seine fishing is of small extent, and in most cases only incidental to the pound-net fisheries.

Between 1876 and 1881 two tugs were used at Little Suamico in tending pound-nets. No tugs have ever been used in gill-net fishing from Oconto County, and at present none are employed in the fisheries for any purpose. No set-lines, trammel-nets, or sturgeon gill-nets are used.

Species.—The principal species taken are herring, perch, suckers, and sturgeon. Up to about 1876 all the fishing was for whitefish. In 1863 1,100 packages, nearly all whitefish, were obtained from four pound-nets. In 1875 two men with sixty nets caught $10\frac{1}{2}$ tons of whitefish in fifty days, but between the latter date and 1881 the species decreased in abundance until it became an insignificant element in the catch. This catastrophe is attributed by the fishermen to overfishing. While the whitefish and the pike have been disappearing the perch have become enormously more abundant. Before 1882 only a few scattering ones were obtained, averaging about six to each lift of the pound-net. Since then they have become more and more numerous each year, until in the spring of 1885 never less than 50 pounds and sometimes as much as a ton of them were taken at a lift. The sturgeon are prepared for shipment by removing the entrails and cutting off the heads, collar-bones, and tails. In that condition they average about

eighty-five to the ton. The entrails are often used by the farmers as a fertilizer.

Shipments and prices.—Most of the products of the fisheries of this county are sent to Chicago, but the caviare and isinglass are shipped to Hamburg, Germany. None of the fish are smoked, although from 25 to 40 per cent. of them are salted, the proportions varying from year to year.

The prices received in 1884 were about as follows: Salt herring, \$1.50 to \$2 a package; fresh herring, 1¼ to 2 cents a pound, sometimes rising to 3½ cents in winter; perch, 1 cent to 1½ cents; whitefish (which are mostly No. 1 in this vicinity), 5 to 8 cents; pike, pickerel, trout, and sturgeon, 4 and 5 cents; No. 2 pike, 3 cents; black bass, 5 and 6 cents; and suckers 1 and 2 cents. The suckers when salted are branded as "bay fish" and sold at \$1.25 a package. Lawyers or eelpouts are thrown away, except during the winter months.

Statistics.—There were in 1885, in Oconto County, 110 fishermen, who used 27 pound-net boats, 16 pile-drivers, and 13 other boats in fishing 79 pound-nets, 745 gill-nets, 2 seines and 28 fyke-nets. The capital invested in floating property was \$2,319, in pound-nets \$10,800, in gill-nets \$3,405, in other apparatus of capture \$570, in buildings and wharves \$7,405, and in fixtures and accessories \$3,510.

The products during the same year were 576,000 pounds of fresh herring, 306,400 pounds of salt herring, 33,430 pounds of fresh whitefish, 14,300 pounds of salt whitefish, 17,800 pounds of fresh trout, 1,100 pounds of salt trout, 70,704 pounds of fresh pike and pickerel, 500 pounds of salted pike and pickerel, 110,000 pounds of fresh perch, and a few hundred pounds of salt perch, 27,505 pounds of sturgeon, 65,000 pounds of miscellaneous fresh fish, including black bass, bull-heads, catfish, lawyers, and suckers, particularly the latter, and 26,400 pounds of salted bay-fish, bull-heads, and catfish. The secondary products were 1,020 pounds of caviare in kegs of 115 pounds each, and 150 pounds of isinglass, valued at \$1.25 a pound. The total price received by the fishermen for the foregoing was \$24,500.

Pound-net fishery.—Pound-nets were introduced at Little Suamico in 1858 and at Oconto in 1861. At present the shores are lined with pound-nets, especially at the mouths of the Oconto and Pensaukee Rivers, where they are set from three to seven in a string.

The nets have a mesh of 2 to 2½ inches in the pot, 4 inches in the hearts, and 4½ inches in the leader. The hearts generally contain 132 feet of netting, and the leader is usually between 660 and 825 feet in length, though it was formerly the custom to have it as long as 1,980 feet. The bowl of the ordinary pound-net is 15 to 34 feet deep, averaging about 18 feet, but a variety only 6 or 8 feet deep is also in common use. Occasionally a net of 10 or 11 feet may be found.

The deep nets are set 2 or 3 miles from land, but the shallow ones are placed much nearer inshore. The deep nets are put in about May 15 for

the spring fishing, and taken out again in July. In the fall they are fished from September 20 to November 20. The principal species caught in the deep nets are herring and perch, the former comprising about seven-eighths of the whole catch; sturgeon, whitefish, suckers, and trout are also taken in small quantities. In 1858 one of the fishermen at Little Suamico got 300 packages of whitefish and 300 packages of herring from two pounds. In 1885 the same man did not get 15 packages of whitefish in three nets, though the difference was made up by the increased herring catch. In 1878 another fisherman obtained 2,400 packages of herring in four nets, and the continued abundance of this species is illustrated by the fact that one Oconto firm, with five deep and two shoal nets, obtained, in 1885, 2,798 packages of herring besides 16,143 pounds of other fish.

The shallow nets are fished from April 20 (or as soon thereafter as the ice will permit) to the first of July, and from the latter part of August to the middle of October. They are set principally for sturgeon, but their leaders are extended into water only 2 feet deep in order to catch other "rough fish," such as dories and suckers. The run of sturgeon is best in September. Before this was noticed it was customary to fish pound-nets only in spring. This branch of the fishery began about the year 1875, when three or four shallow nets for sturgeon were set for the first time in these waters. In 1875 two such nets stocked $1,100 in six weeks, although the dories brought only 1½ cents per pound and the sturgeon only 1 cent per pound.

Some of the fishermen have a pen 80 feet long by 60 feet wide made of heavy twine hung on piles driven in 8 feet of water. In this the sturgeon caught during the spring months are kept alive until the middle of July, when they are shipped to market. The fall catch is penned only for a few days. Caviare is made only in the fall, as the fish spawn in the spring and suitable eggs could not be obtained without slaughtering the fish early in the season.

There were in Oconto County twenty-five crews, fishing eighty-three nets, in 1884, and twenty-two crews with seventy-nine nets, in 1885.

The products of the fishery in the former year are shown in the following table:

How sold.	Whitefish.	Trout.	Pike.	Sturgeon.	Herring.	Other fish.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Fresh	18,800	6,600	74,550	63,700	200,800	17,050	381,500
Salt	6,700	2,000	7,250		192,500	4,255	212,705
Total	25,500	8,600	81,800	63,700	393,300	21,305	594,205

Gill-net fishery.—Over thirty of the pound-net fishermen and a number of others make a practice of fishing with gill-nets through the ice during the winter months. Two kinds of nets are used. One is 35 fathoms long and 20 meshes deep, with a 3-inch mesh, and has a

value of about $5. This is used for the capture of herring and perch. The other kind, intended for whitefish, is 50 fathoms long and 16 meshes deep, with a 4½-inch mesh. Both kinds are ordinarily rigged with the old fashioned float and stone.

The season usually begins about the first of January and lasts from forty to seventy days. The herring gill-netters of Little Suamico begin earlier and get most of their fish between December 1 and January 15. The usual outfit of a crew of ice fishermen is from twenty to sixty nets; a shanty costing $25; two chisels, a scoop-shovel, and two axes, with a value of $6; a hand-sled, $2; a horse, $150; a "skeeter," $7; a reel with 300 feet of rope, $12; and a long pole, hereafter to be described, $5. The shanty is 14 feet long and 7 feet wide, with unshod wooden runners. It contains a stove, and is covered with a duck roof, which projects on each side to form an 18-inch gable.

The method of fishing is somewhat peculiar. Four holes are cut in the ice 100 feet apart, at a place where the water is from 50 to 60 feet deep. The first one is in the shape of an elongated rectangle, the two middle ones are round and about 1 foot in diameter, while the last is 2½ feet square. A strip of boards 100 feet long and 4 to 6 inches wide is used in setting the nets. It has a 3-foot tail-line, and a long line which runs along its entire length, with considerable slack. The pole is pushed into the rectangular hole, which is made longer or shorter according to the thickness of the ice. The net is paid into the long hole by one of the men, and is reeled back by the other. The reel, which is moved about on a hand-sled, has a knee-board 1 inch thick, 6 inches wide, and 1 foot long, and a net-board about 4 feet long by 2½ wide. Several nets are set in a string, and the end of each net is attached by a bridle-line to the stone-line. One stone-line is fastened to each end of the string and one at each point where two nets come together. The stone-line is attached near the surface to the longer arm of a hook of wood, naturally or, in some cases, artificially bent, the crotch of which is supported by a cross-stick 3 to 4 feet long and 2 inches thick, which lies upon the ice across the hole through which the former protrudes. The stone anchor at the other end of the line is about twenty pounds in weight.

When there are three men, one chops holes and reels the nets while the other two pay out, lift the nets and dress the fish. All work is done in the shanty, and, while lifting, the horse and skeeter are left in the lee of the shanty. The latter is moved from hole to hole as needed, and is left at the close of the day's work beside the hole where the lifting is to begin in the morning.

The catch is about 75 per cent. whitefish, which sell at 8 cents per pound, 4 per cent. each of trout and dories, and 17 per cent. suckers.

Hand-line ice-fishing.—There is still considerable hand-line fishing or "bobbing" through the ice, although the business has very much decreased. In former years it was almost universally practiced and very

profitable. In bobbing for whitefish in 1861 one man made $128 per month and board at $4 per week. At that time the fish brought 20 to 25 cents apiece.

Haul-seine fishery.—Thirty years ago there was considerable fishing with large seines requiring eight to ten men each; but in 1885 only two seines were fished in the entire region. These were 990 and 1,125 feet in length, and were the property of some of the pound-net fishermen, who used them from May to July and, rarely, later in the summer, for rough fish, such as pike, pickerel, perch, and suckers. The catch yielded $150 to $200 in a season. In 1884 there were three seines, two at Pensaukee and one at Little Suamico. There were two additional seines owned at Oconto, but they had not been fished since 1883.

Fyke-net fishery.—Sixteen of the twenty-seven fykes owned in Oconto County belong at Pensaukee, and the remainder, with two exceptions, at Little Suamico. The kind used has a hoop 5 feet in diameter, with wings 82 feet long, and a 165-foot leader. They are set in 6 to 10 feet of water in winter and in still shoaler water in summer. They are fished from the late winter to the early summer for perch, suckers, black bass, pike, and pickerel.

Other fisheries.—The only fishing not mentioned in the preceding sections is a little pike and sucker spearing in the rivers after they have opened in spring.

41. SUAMICO TO GREEN BAY CITY, BROWN COUNTY, WISCONSIN.

Physical characteristics of the coast.—Above the mouth of the Little Suamico River the shores of the bay begin to rapidly converge towards its head, which, from Big Suamico River, 6 miles south of the Little Suamico, to Green Bay City, is about 7 miles wide and from 5 to 20 feet in depth, the deepest spots in the center not exceeding 4 fathoms. About 2 miles to the south of the Little Suamico is the line of Brown County, all of which will be treated of in this section, with the exception of the little strip of coast between Bay Settlement and Dyckesville, on the eastern shore of the bay. The principal streams of this region are the Big Suamico, about 4 miles from the county line, Duck Creek, 6 miles south, and the Fox River, 4 miles east of Duck Creek, at the very head of the bay, into which it conveys the waters of Lake Winnebago and the Devil River. The latter flows parallel with the Fox for nearly 15 miles and finally unites with it at Green Bay City.

Review of fisheries by localities.—Green Bay was founded in 1745, and is therefore the oldest city in the northwestern states. It is now a place of 8,000 inhabitants and the county seat. Its shipping facilities are unsurpassed, as it is an important railway center and the terminus of the Fox River Canal. The fishery interests consist of two firms of wholesale dealers and ten crews of fyke-net, seine, and gill-net fishermen.

Fort Howard immediately adjoins Green Bay on the west and is connected with it by three substantial bridges across the Fox River. It has a population of 4,000, and is entered by three railways and several lines of steamers. It has a half dozen crews of gill-net fishermen and two others fishing with fyke-nets, gill-nets, and one pound-net.

The 250 inhabitants of Velp, a post-office settlement on the Duck River, 4 miles northwest of Green Bay, are dependent for a livelihood principally upon the shipment of stone, brick, lumber, ties, and cordwood, and include only two crews of fyke-net and gill-net fishermen.

Suamico, on Big Suamico River, 9 miles north of Green Bay, is an incorporated village of 300 inhabitants engaged in the lumber business, with the exception of two crews of herring gill-net fishermen, one of whom fishes fyke-nets as well.

The foregoing include all of the settlements on the shore of Brown County west of Bay Settlement. The latter will be included in the section treated in the next chapter. There should be mentioned, in addition, the towns of De Pere and Menasha, situated on the Fox River, between Green Bay and Lake Winnebago.

Character of the fisheries.—As will be seen, the fisheries of the settlements on the shore of Brown County form at the present time by no means an important element of its prosperity. They are carried on upon a small scale throughout the year. The herring gill-net fishing occupies the winter months. This is followed in the spring by seining or pickerel netting. After the close of the pickerel netting season the set-line fishing for catfish begins. In the fall the seining is renewed. Fyke-nets are set for "rough fish" both in spring and fall.

Species taken.—Catfish are very plentiful in the Fox River just before freezing. In the season of 1882 there were eighteen thousand in number taken at one haul of the seine 2 miles south of Green Bay. In the fall of 1884, six thousand six hundred were caught, 3 miles south of Green Bay, at one haul.

The catch consists principally of perch, pike, pickerel, herring, suckers, bay-fish, and catfish. Muskallonge, black bass, bull-heads, white bass, crappies, sunfish, and shad, or moonfish, are also taken in smaller quantities. Not one whitefish had been caught within 17 miles of Green Bay City since 1882. The trout also are entirely absent from the headwaters of the bay, and sturgeon are rarely obtained.

Trade.—Most of the products are sold fresh at Green Bay City. Two firms had three small steamers in 1885 which were used during the whole season of navigation in purchasing fish from other portions of Green Bay. In addition to these the 40-ton steamer *Lottie May* was employed nine months of the year in collecting salt fish for another firm. A fourth dealer began operations on a small scale in the spring of 1885, purchasing both fresh and salt fish from the eastern shore of the bay between Green Bay and Red River.

One of the fresh-fish firms dates back to 1868 and the other to 1878.

The following tables show the quantity of fish handled by the dealers at Green Bay City during 1884 and 1885:

Trade of wholesale fish dealers of Green Bay City, Wisconsin, in 1884.

Species.	Fresh.		Salted.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bay-fish or suckers	95, 067	$880	358, 800	$4, 284	453, 867	$5, 164
Black bass	27, 608	1, 526			27, 608	1, 526
Bull-heads (skinned)	34, 687	1, 294			34, 687	1, 294
Catfish (skinned)	111, 172	8, 287			111, 172	8, 287
Croppies and sunfish	4, 433	200			4, 433	200
Herring	87, 467	2, 187	580, 600	12, 015	668, 067	14, 202
Perch (rough)	272, 000	2, 720			272, 000	2, 720
Perch (skinned)	115, 342	4, 037			115, 342	4, 037
Pickerel	121, 003	2, 800			121, 003	2, 800
Pike	125, 965	3, 009			125, 965	3, 009
Muskallonge	3, 000	240			3, 000	240
Sturgeon	138, 454	5, 538			138, 454	5, 538
Trout	226 670	12, 266	46, 800	2, 022	273, 470	14, 288
White bass	9, 423	470			9, 423	470
Whitefish	195, 000	12, 100	55, 000	3, 300	250, 000	15, 400
Other species	2, 500	25			2, 500	25
Secondary products						[1] 160
Total	1, 569, 791	57, 579	1, 041, 200	21, 621	2, 610, 991	79, 360

[1] Amount obtained for 3,200 sturgeon bladders or sounds.

Trade of wholesale fish dealers of Green Bay City, Wisconsin, in 1885.

Species.	Fresh.		Frozen.		Salted.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Bay-fish or suckers	111, 639	$1, 300			375, 391	$5, 500	487, 030	$6, 800
Black-bass	18, 821	1, 252					18, 821	1, 252
Bull-heads (skinned)	13, 088	392					13, 088	392
Catfish (skinned)	145, 944	6, 638			12, 000	480	157, 944	7, 118
Croppies and sunfish	829	40					829	40
Herring	83, 686	2, 208	9, 714	302	586, 600	14, 666	680, 000	17, 176
Muskallonge	1, 200	96					1, 200	96
Perch	507, 095	7, 019	30, 851	600			537, 946	7, 619
Pickerel	201, 038	8, 452	8, 570	428			209, 608	8, 880
Pike	174, 281	7, 794	4, 123	206			178, 404	8, 000
Sturgeon	87, 907	3, 516					87, 907	3, 516
Trout	266, 040	12, 737	12, 350	616	88, 610	3, 852	367, 000	17, 205
White bass	4, 806	215					4, 806	215
Whitefish	184, 452	11, 832	10, 650	743	54, 898	3, 708	250, 000	16, 283
Shad or moon-eye	1, 000	20					1, 000	20
Secondary products								[1] 75
Total	1, 801, 826	63, 511	76, 258	2, 895	1, 117, 499	28, 206	2, 995, 583	94, 687

[1] Amount obtained for 1,500 sturgeon bladders or sounds.

About half of the fresh fish are shipped to Chicago and the rest go to Milwaukee, Kansas City, St. Louis, Topeka, Denver, and small towns in Illinois, Iowa, and Nebraska. All of the sturgeon-bladders go to Chicago to be made into isinglass. A large part of the salt fish are sent to Buffalo and Syracuse, New York. Most of the whitefish and trout are sold locally or to towns in the interior of the State. The fresh-fish dealers occasionally purchase a few packages of salt fish from the fishermen, and also make a practice of salting their fish whenever there

happens to be a surplus. The catfish and bull-heads and a great many of the perch are dressed and skinned before shipment.

Manufacture of salt-fish packages.—A considerable industry has sprung up at Green Bay, De Pere, and Menasha in the manufacture of wooden packages for salt fish. They are made of clear white pine with flat hoops of black or swamp ash. The material is obtained between November and April by the farmers, who go into the woods for the purpose and earn $2 a day at this business. In addition to three large firms, several private coopers devote themselves to the manufacture of fish-barrels and kits.

The firms at De Pere and Menasha are wooden-ware companies, and the supplying of the fish trade constitutes only about one-sixth of their business. The total amount invested in this business in the three towns is $22,000. About a dozen men work on fish packages, making altogether 22,000 half-barrels, 52,000 quarter-barrels, and 400,000 kits or pails with handles.

Statistics.—In 1885 the fisheries of that portion of Brown County under consideration gave employment to 25 professional and 58 semi-professional fishermen and to 30 shoresmen and preparators, the dependent population amounting to several hundred persons. The four collecting tugs were worth $11,000, and there were in addition 8 pound-net boats, 4 seine-boats, and 32 other boats, the value of these amounting to $1,240. The number of gill-nets was 260, of pound-nets 7, of seines 7, and of fyke-nets 215. The value of the apparatus of capture, including set-lines, was $6,068. The cash capital was $15,200, that invested in buildings $4,225, and that in accessories and fixtures $5,860. The products consisted of 365,000 pounds of pike and pickerel, 2,200 pounds of sturgeon, 310,000 pounds of fresh herring, 50,000 pounds of salt herring, 150,000 pounds of catfish and bull-heads, 480,000 pounds of perch, 245,000 pounds of suckers or bay-fish, 18,200 pounds of other fresh fish, and 6,000 pounds of mixed salted fish, mostly bay-fish.

Pound-net fishery.—This fishery is of small proportions, being limited entirely to a few pound-nets set just east of the mouth of Fox River. One of them is owned by a man who resides between Bay Settlement and Namur, and is therefore included in the statistics of that section. The pound-nets of this section have pots from 12 to 14 feet deep and 14 feet square, with a 3-inch mesh. The leader is usually about 990 feet in length. The boats used in fishing them are flat-bottomed and square-sterned, about 22 feet long, with a 6-foot beam, a stern 4 feet broad, and a long, sharp-pointed bow. They are worth about $75 each.

Gill-net fishery.—Gill-nets are fished through the ice from the 1st of January till after the middle of March, in the mouth of the Fox River, and as far north as Little Suamico on both sides of the bay and in the deep water. Most of the fishermen belong at Green Bay City and Fort Howard, but there are several at Velp, Big Suamico, and De Pere, and

others come in from the country during the fishing season. The nets are usually set for herring outside of the sand spit known as the Little Tail, but when herring are scarce they are fished inside of the Little Tail for perch. A good many pickerel are also taken. The only open water fishing is with nets having a 3½-inch mesh for pickerel during three or four weeks after the breaking up of the ice in spring.

Each fisherman has three to five pickerel-nets, and eight to fifteen herring-nets for ice fishing. Two men usually put their nets together and fish in common. Many of the gill-net men use a few fykes at the same time. The value of their catch will average about $2 per day.

Haul-seine fishery.—Seven seines, from 660 to 1,320 feet in length, averaging 990 feet, are owned at Green Bay City and on the shore a few miles to the east. The fishing begins when the ice goes out, from the 1st to the 25th of April, and terminates between the 10th and 30th of June. It is resumed in the fall about September 1, or in some cases not until October 15, and is not discontinued until the end of November. The hauling is generally done at night on the Fox River or the beach at the head of the bay. Some of the crews consist of two men with one horse to assist them in hauling; others have three or four men. The average yield is $300 per annum to each seine, divided as follows: 30 per cent. pike, 20 per cent. pickerel, 25 per cent. catfish, 15 per cent. perch, and 10 per cent. bay-fish or suckers.

Fyke-net fishery.—The fyke-net was first introduced into the fisheries of this region about twenty years ago, although prior to 1880 it was a rare occurrence for any one to make a business of fishing with such apparatus. Scores of them are now in use, belonging usually to the gill-net or seine fishermen, though in some cases their owners are persons who do no other fishing. Occasionally, single fykes are fished for pleasure or home supply.

Those now used are from 4 to 6 feet in diameter at the mouth, and have two funnels. The hearts contain 24 to 30 feet of netting each, and the leaders are 200 feet long, with a 4-inch mesh. Although the cost of a new one is $30 or $35, the average value of those actually in use can not be placed higher than $15 or $20. A small scow, 15 feet long, with a 4-foot beam, is usually employed in setting and lifting the nets. It is 3 feet wide at the bow and 2½ feet at the stern. It has a center-board with a box 3½ feet long, nine knees, a bottom rounding up at stem and stern, and a place to step mast forward. It is worth $12 or $15 when new. In those cases in which fykes are owned by pound-net fishermen they are fished from ordinary pound-boats. They are set particularly in the mouth of Duck Creek, but also in the Fox River and the intervening sloughs along the bay shore. Each man fishes his own nets, without needing any one to assist him. If the weather is bad he tends half his nets each day, but otherwise he lifts the whole number, usually about ten. The season extends throughout the entire year, with the exception of July and part of August. In winter the fykes are fished

through holes cut in the ice. All the species common to the region are taken. The most successful fisherman obtained, in 1884, nearly $600 worth of fish in twelve fykes.

Set-line fishery.—After the close of the pickerel netting season, the the fishing for catfish with set-lines begins and is continued until the first of July. Some twenty persons, mostly boys, earn about $3.50 a week at this business in the months of May and June. The fish caught average 5 or 6 pounds apiece, and bring 1½ cents a pound before being dressed.

42. BAY SETTLEMENT, BROWN COUNTY, TO NAMUR, DOOR COUNTY, WISCONSIN.

Geographical description.—Between the city of Green Bay and the fishing village of Little Sturgeon is an agricultural section, with a population consisting almost entirely of immigrants from Belgium, except in the southern portion, where there is a large native element. It has been pretty well settled with farmers for nearly thirty years. There are no villages, the post-offices of Bay Settlement, Wequiock, Dyckesville, Red River, and Namur having at most no more than half a dozen houses in their immediate vicinity. The lumbering interests, which were formerly extensive, have greatly declined, and farming and fishing engross almost the entire attention of the people. The shores of this portion of Green Bay are variable, high in some places and in others low and sandy. The water is very shoal just north of Green Bay City, but deepens as we proceed northward. There are some excellent seining grounds along the coast, south of Red River, especially at Port Sable, a long, low cape about ten miles above the city, said to be the most desirable site for the prosecution of the seine-fishery on the whole of Green Bay.

Character of the fisheries.—There never has been any large number of persons in this region who derived from the water their entire support throughout the year, but the fisheries are, nevertheless, of much importance. A number of the farmers south of Dyckesville have seines with which they extensively supplement their income, and there is scarcely a farmer in the section around Dyckesville post-office and north of it who does not make a practice of fishing gill-nets in winter as long as the ice is strong enough to be safe. There are several pound-nets fished near Dyckesville and a greater number just north of Namur. A few fyke-nets and set-lines are also employed.

Statistics.—The total amount of capital invested in the fisheries here in 1885 was $25,043, of which $3,250 was included in the pound-net fishery, $19,145 in the gill-net fishery, $2,365 in the seine fishery, and $283 in the minor fisheries. The products, which were all sold fresh, mostly to Green Bay dealers, were worth $18,454, and consisted of 147,000 pounds of whitefish, 92,725 pounds of pike and pickerel, 58,450 pounds of sturgeon, 56,125 pounds of perch, 53,580 pounds of suckers, 33,445

pounds of trout, 31,785 pounds of catfish, 27,285 pounds of bass, and 13,570 pounds of herring.

Pound-net fishery.—The pound-nets are rather shallow, being set in water from 12 to 45 feet deep, most of them between 20 and 30 feet. The leaders vary from 825 to 1,155 feet. There is no uniformity in the matter of fishing season. Most of the nets are fished throughout the season of open water, except for three or four weeks in summer, when they are taken out to be cleaned and tarred. Several are set only in the spring and others only in the fall. The catch is growing poorer each year, and in 1885 amounted to 116,900 pounds, bringing $4,325, this representing the labor of 19 men with 12 pound-nets, worth $2,625, and seven boats worth $175, together with fish houses and accessories having a value of $450.

Gill-net fishery.—Gill-nets are very little used south of the immediate vicinity of Dyckesville, but from there to Little Sturgeon the winter fishery with this form of apparatus is very extensive and important. None are set in open water, the fishing being almost entirely by farmers who devote themselves to fishing through the ice at a season when no agricultural work can be done. Each crew of two or three men has a shanty 10 by 16 feet, which is usually hauled to and from the fishing-grounds by means of one of their farm horses. The fishing is mostly directly off the shore, but some go north to the vicinity of Little Sturgeon, which has long been noted as a winter fishing station. Most of the catch is sold to Green Bay firms, who send up teams nearly every day to collect the fish; but small quantities go to Little Sturgeon and Oconto. The nets used are 40 and 45 fathoms long, 14 and 16 meshes deep, and with a mesh of 4½ to 4¾ inches. A few which are fished for herring are 30 fathoms long and about 30 meshes deep, with a mesh of 2½ or, more commonly, 3 inches. The catch in the whitefish nets is about 80 per cent. whitefish, 17 per cent. trout, and 3 per cent. pike and pickerel.

In the winter of 1884–'85 there were two crews south of Dyckesville, twenty-five crews from the vicinity of Dyckesville and Red River, and twenty-two crews from the region around Namur. Many crews contain 3 men and all have at least 2, but about 16 men out of the entire number are included under other fisheries to which they give their principal attention. The total number of those engaged in this fishery alone for the region under consideration was 102. There were 2,945 nets, worth $15,700, and the accessories, such as movable shanties, horses to drag them, and shore houses and reels, had a combined value of $7,795.

Seine fishery.—The eastern shore of Green Bay for the first ten miles from its head is low and sandy and excellently adapted to the use of seines, and something over 200 acres of shore land, worth about $3,000, are owned by fishermen and used exclusively for this purpose. Some of the fishermen who have no land of their own pay 20 per cent.

of the gross value of their catch for the use of their neighbor's seining reach. The first seine was introduced in 1873. The fishing was most profitable about 1880, when, as we are informed, $1,000 worth of fish was captured during a single month in a seine similar to one which in 1885 caught only $800 worth for the entire year. There are 11 seines owned south of Namur in the present year, besides one which has not been used for several years and probably will not be again, on account of its mesh being now illegal. The length of the seines used varies from 825 to 1,650 feet, averaging about 1,100 feet. The depth is usually 12 feet in the bag and 4 feet on the brail; but one which is owned by Mr. Jeffrey has a 14-foot bag and a 5-foot brail. Formerly the size of mesh used was 1½ to 2 inches, but, owing to the foresight and enterprise of one of the leading fishermen, a change has taken place in the last four or five years, and at present the usual size is 3 inches in the bag, 4 inches in the inner portion of the wings, 5 inches in the center of the wings, and 5 to 7 inches at the outer ends.

In most cases there are only two sizes of mesh in the wings, but there are several seines in which the 5-inch mesh at the center is replaced towards the brail by a 7-inch strip, making four different sizes in the entire net. The boats used are flat-bottomed skiffs, worth from $15 to $25 each. Nearly all of the fishermen are farmers who fish regularly only from the clearing away of the ice in the spring to the early part of June; though occasional hauls are made from time to time throughout the season of open water. Four men are required to fish one seine, but where two seines are owned by one man they are fished by the same crew. Two of the seining crews are engaged also in the pound-net fishery; including these there are forty men employed in the seine fishery of this region. The catch consists of rough fish, the proportion of each species to the entire quantity of fish marketed being as follows: perch, pike, and suckers, each 25 per cent.; catfish, 10 per cent.; white bass, black bass, and pickerel, each 5 per cent. The average price obtained per pound was 5 cents for black bass, 3½ cents for pickerel, 3¼ cents for pike, 3 cents for catfish, 2½ cents for white bass, half a cent for perch, and half a cent for suckers. The catfish are dressed before being sold; the other varieties are all sold round. The above prices are for the fish as sold. The entire marketable catch goes in a fresh state to three firms at Green Bay City. Up to 1883 there was no demand for suckers and they were all thrown away, but in that and later years they have been saved. At present there are not over eight half-barrels of waste fish of all kinds to a seine, and this is buried on shore; thus far there is no record of its having been used as a fertilizer in the vicinity. The catch in 1885 amounted to 84,335 pounds, valued at $3,695.

Fyke-nets.—Twenty fyke-nets are fished throughout the year on the shore between Green Bay and Wequiock by four professional fishermen, each of whom operates five nets. The nets are about 10½ feet long, with three or four hoops from 3 to 8 feet in diameter. The catch

consisted of about 30,000 pounds of perch, pike, and pickerel, herring, and suckers, valued at $500.

Hand-lines and set-lines.—No hand-lines are used in the commercial fisheries, and there are only nine set-lines, with one hundred hooks each, along the entire stretch of coast. These are employed for catfish, which are sold fresh to Green Bay dealers at 3 cents a pound dressed. One farmer and one seine fisherman are the owners of the lines and use them more or less throughout the season of open water, but principally in the month of June.

43. LITTLE STURGEON AND VICINITY, DOOR COUNTY, WISCONSIN.

Population.—The residents between Namur and the entrance to Sturgeon Bay are extensively interested in the fisheries. Most of them farm in summer and fish in winter, but there are some who throughout the year give their attention exclusively to fishing. They are of several nationalities; towards Namur nearly all are Belgians, while further north they are mostly Scandinavians, with a few native-born Americans. There are no villages with the exception of Little Sturgeon, situated just inside the entrance to Little Sturgeon Bay. The present population is not over 75; though seven or eight years ago, when a lumber-mill was in regular operation, the number was several times as large. Between 1870 and 1872 large quantities of ice were cut here in winter and shipped to Chicago, but that business was not continued, and since 1877 fishing and farming have been the only occupations.

Character of shore and fisheries.—The neighboring shores though not very high are generally rather bold. The bottom is too rocky to admit of the use of seines, and the fishing is carried on exclusively with pounds, gill-nets, and fykes.

Disposition of catch.—In 1875 and previously the entire catch was salted, but at present it is sold fresh, none at all being salted and none being smoked except occasional lots of sturgeon for home use. Nearly one-third of the winter catch is bought by a local firm.

Statistics.—The number of fishermen in this region in 1885 was 87, and the total amount of capital invested was $17,260, of which $7,000 was in the pound-net fishery, $10,910 in the gill-net fisheries, and $350 in the fyke-net fishery. The products amounted to 377,055 pounds, valued at $15,500, and divided as follows among the different species: 201,400 pounds white-fish, 40,425 pounds trout, 61,530 pounds herring, and 64,700 pounds of perch, sturgeon, suckers, and minor species. The entire catch with the exception of 12,500 pounds, valued at $655, was sold fresh.

Pound-net fishery.—Prior to the opening of the canal connecting the head of Sturgeon Bay with Lake Michigan there were very few pound-nets around its mouth, but new currents admitted by the canal brought to the spot great quantities of fish, and there are now twenty

pound-nets between the immediate vicinity of Little Sturgeon and the northern headlands of Sturgeon Bay.

The nets are in water varying from 11 to 65 feet deep; most of them are set in about 30 feet; the only ones in a greater depth are two in 65 feet, and four others in 46, 43, 40, and 35 feet, respectively. The length of lead is from 577 to 1,320 feet, averaging 1,155 feet; the mesh averages 7 inches in the lead, 6 inches in the heart, and 3¼ in the pot. The largest size used in the pot is 3½ inches, and the smallest is 2¾ inches. The value of the twenty nets is $5,900; of the boats $200; and of the shore property, pile-drivers and other accessories $900. There were seventeen pound-net fishermen in 1885, and the products amounted to 98,155 pounds, and sold for $2,400.

Gill-net fishery.—There were in the year 1885 between Namur and Sawyer, exclusive of those settlements, nine crews fishing with gill-nets during the whole or a part of the season of open water, and thirty-nine crews, including the nine fishing also in summer, who set their nets under the ice. Most of them were composed of farmers who lived permanently in the vicinity, but four of the crews were from Chippewa Point, and are included in the statistics of the pound-net fishermen in Big Bay de Noquet, while four others were owners of pound-nets on the neighboring shores. Out of the total number of gill-net fishermen there were, therefore, eighteen men who have been properly credited to other fisheries or localities, leaving seventy local fishermen who use gill-nets principally or wholly. The number of gill-nets fished is 1,736, worth $8,755. A little over one-eighth are rigged with cork and lead; all the rest have the old-fashioned float and stone. The value of the boats used in the summer fishing is $345, and that of the shanties used on the ice is $400. The shore-houses and accessories have a total value of $1,410. The summer fishing from Little Sturgeon is carried on very irregularly. Two of the crews fished at Hat Island, off Fish Creek, in 1885. Five others fished at different places along the shore for one or two months in the spring, commencing about the middle of April, and for a month or six weeks in the fall, beginning about the first of November. The other two crews of summer fishermen are farmers, who fish only occasionally during that portion of the year. The winter fishing is carried on from the first or middle of January to the 15th of February. After that it is dangerous to leave the nets in the water, as they are very apt to be entirely destroyed by a kind of rot by which they are attacked. This trouble has only arisen in the last five or six years and is attributed by some to the pollution of the water with spoiled fish and offal.

The total products of the gill-net fisheries of Little Sturgeon and vicinity in 1885 were 252,000 pounds, valued at $12,430.

Fyke-net fishery.—Eight men, who gave their principal attention to the pound-net and gill-net fisheries, fished eighteen fyke-nets, worth $350, from six weeks to two months in the spring, and occasionally in the summer and fall. Most of the nets are 20 feet long, with hoops 3

to 3½ feet in diameter and a 3-inch mesh. They are set close to the shore, the stakes being driven in 6 feet of water. The catch in 1885 consisted of 24,900 pounds of perch, whitefish, suckers, bass, catfish, and pike, valued at $630.

Hand-line fishery.—A number of men fish occasionally through the ice, with hook and line, for herring, to amuse themselves or make a little money, and some of the gill-net fishermen use herring-lines to slightly increase their catch, but the fishery is altogether insignificant, and not more than 1,000 pounds are caught in a season.

44. STURGEON BAY AND CANAL, DOOR COUNTY, WISCONSIN.

Geography of the section.—Sturgeon Bay is an arm of Green Bay, which extends deeply into Green Bay Peninsula about midway of its length. It is an excellent harbor and is the site of the flourishing village of Sturgeon Bay, with a population of 1,800. Directly opposite Sturgeon Bay, and communicating with it by a steam ferry, is the much smaller village of Sawyer, locally known as Bay View.

Character of the fisheries.—Though Sturgeon Bay has been settled for over a quarter of a century, there were no fisheries of importance prior to 1882, except under the ice in winter; but the cutting of a short canal from the head of Sturgeon Bay to the open waters of Lake Michigan admitted new currents which caused a wonderful increase in the quantity of fish, and gave rise to important summer fisheries in the waters which they affected. To this cause the extensive pound-net fishery near the mouth of the bay owes its existence; but the bay itself contains only eight nets, including those on its terminal headlands, though two other nets situated in Lake Michigan just outside the canal, and owned by persons living on the canal, are included here in the statistics. The gill-net fisheries of the bay are more extensive; in addition to a number of sail-boats there was a steamer fishing in 1884, and a second was added in 1885. Pound-nets and gill-nets are the only apparatus used to any noticeable extent.

Trade.—Since 1882 there have been two firms at Sturgeon Bay engaged in buying fish from the fishermen of the surrounding region, one of whom also deals extensively in fish at Green Bay City.

Both of these parties buy fresh fish principally; one ships largely to the West, especially to St. Louis, St. Joseph, and Kansas City, Mo.; Leavenworth, Kans., and Denver, Colo.; while the other disposes of all his fish in Chicago and Milwaukee.

These dealers do not control the entire trade of the locality, for a good many pounds of fish are sold annually to Green Bay, Menominee, and Ahnapee parties. Sturgeon Bay has a freezing establishment, with a capacity for 85 tons of fish. This employs six men and in the season of 1884–'85 froze 30 tons of whitefish, 30 tons of trout, 5 tons of herring, and a few dories. In 1884 the freezing began November 1 and frozen fish were on hand from that time until April 15. In 1885 the season

commenced about the middle of October. The price charged for freezing is 2 cents a pound and the fish frozen belong almost exclusively to one dealer.

Statistics.—The amount of capital invested in the fisheries of Sturgeon Bay and canal in 1885 was $23,687, of which $13,052 was in the gill-net fishery, $2,715 in the pound-net fishery, and $7,900 in dealers' establishments and freezer. The products amounted to 282,145 pounds, valued at $8,112, divided as follows: 154,060 pounds of whitefish, 60,125 pounds of trout, 55,060 pounds of herring, and 12,900 pounds of sturgeon, pike, and minor varieties. One thousand pounds of whitefish and 14,500 pounds of herring were salted. The quantity of fish handled by the dealers was about 300,000 pounds, consisting chiefly of trout and whitefish. Of this amount 90,320 pounds of trout and 450 pounds of whitefish were frozen. In 1884 the same dealers handled 1,000,000 pounds, of which 130,000 pounds were frozen.

Pound-net fishery.—As has been stated, the pound-net fishery in these waters is of recent origin, and it is far less important within the bay and at the lake end of the canal than it is outside the entrance of the bay, and especially between it and Little Sturgeon. In 1884 there were nine nets in the mouth of the bay and two at the mouth of the canal, and in 1885 there were the same number at the canal and one less in the bay. These ten nets are of quite different depths. Those in Lake Michigan near the canal are 24 feet deep; of the eight on the Green Bay side one is in 12 feet of water, one in 14 feet, two in 40 feet, two in 42 feet, one in 45 feet, and one in 80 feet. The length of lead varies in the same way; there is one of 14 rods, one of 20, two of 40, two of 50, three of 60, and one of 80 rods. The size of mesh is 5, 6, and 7 inches in the leads, 5 and 6 inches in the hearts, and from 2 to $3\frac{1}{4}$ inches in the pots. The fishing season extends throughout the time of open water, except that the greater part of the nets are taken out for about a month in the summer, some in July and others in August. Most of the catch is obtained after the middle of October. Mr. G. M. Roberts, who is the owner of four of the pound-nets, tried the experiment several years ago of fishing pound-nets in winter, but met with very poor success and abandoned the project.

In 1885 nine men were employed in fishing the ten pound-nets, which had a value of $2,080. The pound-boats were worth $355, and the amount invested in shore-houses and accessories was $280. The catch of fresh fish amounted to 121,845 pounds, which sold for $3,040. The quantities of the different species were 52,960 pounds of whitefish, 40,060 pounds of herring, 6,900 pounds of sturgeon, 1,925 pounds of trout, and 4,500 pounds of pike, perch, suckers, etc. In addition to these quantities, 1,000 pounds of whitefish and 14,500 pounds of herring were salted by the fishermen.

Gill-net fishery.—Fishing with gill-nets is at present carried on in these waters at all seasons of the year. In Bay View and its vicinity

there were four crews who fished under the ice from January 1 to February 15, and three of them fished in open water during the month of May, and from October 10 to December 15. They obtained their best fishing in the month of November. On the canal there was one crew which employed fifty nets from May 1 to November 20. There was also a crew of pound-net fishermen who operated gill-nets during the months of January, February, and March, after which they fished in Green Bay usually 8 or 9 miles off the mouth of Sturgeon Bay. The pound-net fishermen on the north side of Sturgeon Bay, west of the town of that name, comprising four crews, likewise engaged in the winter gill-net fishing.

All the other winter gill-net fishermen making their headquarters on these shores, with the exception of a couple of visiting crews of Chippewa Point pound-net fishermen, were residents of the village of Sturgeon Bay itself. The village had seven crews fishing with this apparatus under the ice, and two firms extensively engaged in the open water fisheries. One firm has owned for several years the steamer *Trescott*, of 8.44 tons, and fished with her in 1884 from August 15 to November 15. In 1885 she did not begin operations until October 20. Another firm, which in 1884 fished from a mackinaw boat with remarkable success, in 1885 employed the steam-tug *A. S. Piper*, 11.80 tons, in the same business. The fishing season was from April 15 to the freezing up of the water in December.

The nets used in this vicinity are from 40 to 50 fathoms long, and from 14 to 22 meshes deep, with a mesh of $4\frac{1}{2}$ to 6 inches when stretched. The average size is 45 fathoms by 16 meshes, with a $4\frac{1}{2}$, $4\frac{3}{4}$, or 5 inch mesh. They are hung in the modern style, with corks and leads. The sail-boats used in the open-water fisheries are mostly square-sterned craft, but the Mackinaw boat is also employed.

Most of the winter fishermen have a horse and wagon with which to go to and from their fishing grounds, but some have hand-sleds with sails instead. Each crew has a shanty on the ice which is moved from one hole to another as circumstances require. The winter crews have two men each and an average of 35 nets.

The catch is almost exclusively whitefish and trout, the proportion of trout being largest with the steamers, one of which is said to have caught only 15 per cent. of whitefish during the whole of 1884. The winter fishermen get nearly all whitefish, while in the fall catch of the Bay View sail-boats the two species were about equally divided. The winter fishing was much more profitable in the beginning of 1885 than it was the previous year. Four or five years ago it was far more so than it has been since.

The total number of gill-net fishermen in 1885 was fifty-one, fourteen of whom were pound-net fishermen who are included in the statistics of that fishery. The number of gill-nets was 1,227, worth $6,267, and the value of the boats, including two tugs and seven sail-boats, was

$3,510, the shore-houses and accessories of various kinds amounting to $3,275. The catch under the ice and in the open water was 179,800 pounds, of which 115,100 pounds were whitefish and 64,700 pounds trout, having a value of $6,135. Fifteen thousand pounds of whitefish and 6,500 pounds of trout were salted. A certain amount of lawyers and suckers is taken, but these species are not considered of any value and are culled out and buried on the shore. Two tons per annum are secured and thus disposed of by each of the Bay View crews, and the total quantity for the bay and canal may be estimated at 80,000 pounds.

Other fisheries.—No trammel-nets or seines are used. In 1884 five or six crews fished set-lines for trout, in connection with their gill-nets, between Sturgeon Bay Canal and Whitefish Bay, and the trial issued favorably, as the catch from the lines was good. For some reason, however, the method was not continued in 1885 by a single crew. Each crew was provided with two lines armed with about four hundred hooks each and worth $10. One man at Sturgeon Bay fished a fyke-net in the spring of 1885, setting it in 8 feet of water. That was the only specimen of this form of apparatus which was used.

45. ENTRANCE OF STURGEON BAY TO DEATH'S DOOR, INCLUDING CHAMBERS ISLAND, DOOR COUNTY, WISCONSIN.

Physical characteristics.—The strait which separates Washington Island from the end of Green Bay Peninsula is popularly called Death's Door. Between this strait and the point where the shore begins to bend inward to form the estuary of Sturgeon Bay is an irregular stretch of coast bordered by a series of bluffs which sometimes come close to the water's edge and again are separated from it by a narrow intervening strip of sandy lowlands. As all the little bays are exposed to the northwest winds there are no really good harbors.

Fishing stations.—Scattered along the shore are numerous small villages and hamlets from which fishing is followed. Among these may be mentioned Sister Bay, Ephraim Bay, Fish Creek, Chambers Island, Egg Harbor, Horseshoe Bay, Thayerport, and Little Harbor.

At Sister Bay and Ephraim Bay gill-nets are sparingly used. Fish Creek, with 200 or 300 people, had more important fishery interests in 1885 than ever before; both pound-nets and gill-nets were employed. The fisheries of Chambers Island have greatly deteriorated since 1875, when they were of considerable extent; in 1885 four or five pound-net and gill-net crews made the island their headquarters. At Egg Harbor the fishing is carried on with small numbers of gill-nets and fykes. One family at Horseshoe Bay is supported by a pound-net set in summer and gill-nets fished in winter. Six American families obtain a livelihood from farming and fishing at Thayerport, employing pound-nets and gill-nets. The population of Little Harbor consists of but six or eight Swedish fishermen who operated pounds in 1885.

North of Sister Bay there are rather extensive hand-line fisheries in winter; in the vicinity of Fish Creek there is also some trout-spearing through the ice, and at several places along the shore a few set-lines and fyke-nets are in use.

Decreased abundance of fish.—According to the principal fisherman of Fish Creek, the quantity of fish has decreased 75 per cent. during the last fifteen years along the whole east side of Green Bay. He attributes the continued success of the fisheries in his town to the increased efficiency of the gill-nets, resulting from greater depth and finer mesh, and the adoption of corks and leads instead of floats and stones.

Disposition of the catch.—Between the years 1850 and 1873 there was a firm on Washington Island buying fish for shipment, and from 1859 to 1880 there was also a dealer at Fish Creek, but on account of the decline in the fisheries both abandoned the business. In 1885 there were no regular buyers of fish located along this shore. A few fish are bought and shipped occasionally by two or three parties at Fish Creek, but most of the catch is either sold locally, shipped directly by the fishermen, or sold to dealers at Menominee, Sturgeon Bay, and Green Bay City.

Statistics.—In 1885 there were 148 men employed in the fisheries of this region; the invested capital amounted to $22,429, consisting of $8,015 in the pound-net fishery, $13,192 in the gill-net fishery, $485 in the winter hand-line and spear fisheries, and $237 in other fisheries, with $500 cash capital. The products amounted to 459,500 pounds, valued at $18,658, of which 264,365 pounds, worth $11,360, were whitefish, 131,360 pounds, worth $5,410, were trout, and 63,775 pounds, worth $1,888, were of other species. Out of the entire quantity, 78,915 pounds of whitefish, worth $3,956, 15,590 pounds of trout, worth $779, and 19,200 pounds of herring, worth $576, were salted; all the rest were sold fresh. The whitefish taken in the years 1884 and 1885 were much larger than those of preceding years, their average weight being nearly 5 pounds. This was attributed to the larger mesh of the nets, and also to the fact that large catches were obtained from grounds where nothing could be caught with a smaller mesh.

Pound-net fishery.—The only pound-nets used in 1885 were four just north of Fish Creek, four on Chambers Island, one at Horseshoe Bay, six at Thayerport, and two at Little Harbor. Formerly this fishery was much more important, especially at Chambers Island. The first pound-net was introduced there in 1869, and the number gradually increased from two in that year to fifteen in 1874–'75. The Chambers Island fishery then declined, and in 1880 there were only one or two pounds. The next year, however, three or four nets were set there and did well; the number increased in 1884 and 1885 to six, that is, if two nets be included which were fished on the island part of the season and were then removed to Ephraim Bay near Fish Creek.

The nets used between Ephraim Bay and Little Harbor vary considerably in dimensions. Those near Fish Creek have leaders of from 247

to 495 feet in length; pots 24 feet square and from 18 to 26 feet deep. Further south the nets are larger; those at Horsehoe Bay, Thayerport, and Little Harbor have leaders 1,237 to over 1,800 feet long, with pots of from 30 to 44 feet square, and 35 to 76 feet deep. The size of mesh in these large nets is from 7 to 9 inches in the leads, 6 or 7 inches in the hearts, and from 3 to 4 inches in the pots. Several of them have a 20-foot strip of netting with a 2-inch mesh on each side of the pot. Various types of boats are used in handling the nets. One of the kinds observed was the Huron boat.

The fishing season is usually from June 1 till the middle or last of July; and from the early part of September until ice begins to close in, about the beginning of December. In 1885 the total number of nets from Ephraim Bay to Little Harbor, inclusive, was 17, valued at $6,300; fishermen employed, 27; the number of boats used was 11, worth $740, and the value of the shore-houses and accessories was estimated at $975. The total catch amounted to 182,905 pounds, worth $5,873. Of this 87,165 pounds of whitefish, worth $3,200; 17,430 pounds of trout, worth $699; and 41,675 pounds of other fish worth $526, were sold fresh; and 13,410 pounds of whitefish, worth $680; 4,025 pounds of trout, worth $201, and 19,200 pounds of herring, worth $576, were salted.

Gill-net fishery.—Gill-nets have been used along this coast—chiefly near Fish Creek—both in summer and winter, for about forty years. The fishery reached its height between 1870 and 1873 when there were fifty or sixty crews engaged in it. A resident of Sturgeon Bay, who was then dealing at Fish Creek, states that in six weeks he paid out $40,000 for salt fish caught along the neighboring shore. At that time, and even until 1883, the entire catch was salted; then the shipment of fresh fish from Sturgeon Bay to Chicago was begun. Two years later three-fifths of the fish taken were sold fresh, a large part of them going through the hands of Green Bay and Sturgeon Bay dealers.

In 1885 there were altogether twenty-eight crews, containing fifty-four men, employed in gill-netting. These were distributed as follows: Sister Bay, four crews; Ephraim, two crews; Fish Creek and Chambers Island, twelve crews; Egg Harbor, three crews; Horseshoe Bay, one crew; Thayerport, two crews; Little Harbor, four crews. Besides these there were nearly a dozen farmers, each of whom had a little flat-bottomed boat and two or three nets, and caught whitefish for a week or two in the beginning of November, salting his catch for winter use. Some of the nets are of the ordinary size; that is, 40 to 50 fathoms long, 14 or 16 meshes deep, and with a mesh of from $4\frac{1}{2}$ to 6 inches; but 235 nets, constituting the entire outfit of ten crews working from Fish Creek in summer, are of double size, 90 fathoms long and 19 meshes deep, with a $5\frac{1}{2}$-inch mesh; and the 152 nets used at Thayerport in winter are from 50 to 52 fathoms long and 30 meshes deep, with a mesh of 4, $4\frac{1}{2}$, $5\frac{1}{2}$, or 6 inches. All of the nets at Fish Creek

are rigged with cork and lead. Both north and south of that place, however, there are still many who prefer the float and stone.

Several kinds of boats are used, ranging from skiffs worth $15 or $20 each to the mackinaw with a value of several hundred dollars. At Fish Creek there are square-sterned and sharp-sterned sail-boats, averaging in value over $150. At the other fishing stations the quality is much inferior; in fact almost all are flat-bottomed craft. In October, 1881, a small steamer, named the *Jessie Blackford*, was introduced into the fisheries of this region.

The fishing season for gill-nets varies considerably. Four crews at Fish Creek, one at Egg Harbor, and three at Thayerport and Little Harbor fish exclusively in the winter. Besides these, there are three crews at Little Harbor and two in the vicinity of Fish Creek who fish in winter and also for a month or two in spring after the ice has cleared away. There are six crews, scattered along at different places, who fish only in the fall, usually beginning about the middle of October. The remaining eleven crews continue their operations throughout a greater part of the season of open water.

The total number of professional fishermen in 1885 was 54, of whom 25 were employed in the summer gill-net fishing exclusively, 8 in the winter gill-net fishing exclusively, 5 in both the winter and spring gill-net fishing, and 9 in both the gill-net and pound-net fisheries; while 2 used both gill-nets and fyke-nets during the open season, and five operated pound-nets in summer and fall and gill-nets in winter and spring. Those who engaged also in the pound-net or fyke-net fisheries are included in the statistics of those fisheries, as they give to them their principal attention. There were in addition 21 farmers who fished occasionally on a very small scale.

The total number of nets used was 1,253, worth $8,037; boats 31, valued at $3,295; besides these there were 3 others worth $85, which were also used in the pound-net and fyke-net fisheries, and are included in those statistics. The total value of the horses, sleds, and shanties employed in the ice fishing was $860, and the value of shore-houses used exclusively in the gill-net fisheries was $1,000, besides $350 invested in property owned by persons operating both pound-nets and gill-nets. The value of minor accessories was $130. The products of the fishery were 98,275 pounds of whitefish and 17,340 pounds of trout, valued at $4,626, sold fresh; 65,515 pounds of whitefish and 11,565 pounds of trout, worth $3,854, salted. The total yield of the fishery was 192,695 pounds, valued at $8,480.

Fyke-net fishery.—There were only ten fyke-nets owned between Death's Door and Sturgeon Bay in 1885, six of which were at Ephraim and four near Egg Harbor. The frame-work of these nets is composed of two or three iron hoops and a rectangular iron frame called the door. This is covered with netting which is extended to form two long wings or leaders, one on each side, and there is a tunnel inside the door through which the fish are conducted into the interior. In a specimen from

which measurements were taken the dimensions of the door were 5 by 2 feet, and the wings were each 83 feet long. There were two hoops about 4 feet in diameter, and one $3\frac{1}{2}$ feet, with a wooden ring 1 foot in diameter at the inner end of the tunnel. The mesh was $4\frac{1}{2}$ inches in the wings and $2\frac{1}{2}$ inches in the body of the trap. The other fyke-nets are of different sizes, some smaller than the above and some much larger. The fishery is of very little importance, and in the summer and fall of 1885 no more than four of the nets were used. Two of the fyke-net crews from Little Sturgeon fish during a portion of the year from Hat Island off Egg Harbor. The catch consists exclusively of bass and perch, and amounted to 1,900 pounds, valued at $95.

Hand-line and set-line fisheries.—North of Sister Bay, on the Green Bay side of the peninsula, and north of Newport on the Lake Michigan side, there is no fishery of any kind except that with hand-lines for trout in winter. At Ellison's Bay both pound-nets and gill-nets have been tried, but without success, and none have been used since 1879. The line fishing has been practised since 1857 and up to 1875 gave employment to about eighty men every winter, half of whom came from other localities, some even from Milwaukee. Of late years the number coming from other places has been decreasing, and in the beginning of 1885 there were not over forty persons engaged in the fishery, all of these coming from the northern portion of the Green Bay peninsula, between Fish Creek and the Door. They are of many different nationalities, though the Scandinavian element predominates. Most of them are farmers, sailors, or lumbermen, who engage in fishing in a semi-professional way. Each has three or four lines and a sled to carry his outfit and catch, with a sail which he uses to keep off the wind while fishing. The fishing is carried on as long as the ice is sufficiently strong to allow it, the season generally extending from the beginning of January to the middle of March. The fish were formerly bought by several dealers, who came over the ice with their teams from various directions, but in 1885 almost the entire trade was controlled by establishments at Green Bay and Sturgeon Bay, which, in the winter of 1884–'85, paid the men an average of 5 cents a pound for their fish. During that season the average catch per man was estimated at from $75 to $100 in value. The yield of this fishery was 68,000 pounds of trout, which brought the fishermen $3,400 in 1885.

The only set-line fishing along the shore under discussion was by the pound-net fishermen at Horseshoe Bay, who employed forty lines with fifty hooks each for trout during two months in the spring just after the ice broke up and during the last four or five weeks of open water in the fall. The catch amounted to only 5,000 pounds in 1885, which sold for $250.

Spear fishery.—In the vicinity of Fish Creek a few men spear trout through the ice. Their catch is sold on the fishing grounds to the dealers' teams at about 7 cents a pound. In 1885 there were eight men spear fishing, five of whom were employed during part of the year

in other fisheries, in the statistics for which they are included. Eight thousand pounds of trout, selling for $560, were taken by spearers in 1885.

46. WASHINGTON ISLAND, DOOR COUNTY, WISCONSIN.

Geographical description.—Washington Island is about 7 miles square, and lies in the mouth of Green Bay, just off the extremity of the Green Bay peninsula. There are two good harbors, in each of which is a small hamlet.

The island is in the line of navigation and readily accessible in summer, but in winter it can only be reached by driving over the ice, which is quite unsafe on account of the currents which frequently break up the ice among the islands at the entrance of Green Bay. Its population is quite heterogeneous; it includes a good many Icelanders and some Americans, but the majority of the inhabitants are Poles. Farming is the principal industry.

About ten families live near Washington Harbor on the northern shore of the island, and the same number at Detroit Harbor on the south. The rest are scattered. Most of the fishermen live at Washington Harbor.

History and character of the fisheries.—The gill-net fisheries were carried on at Washington Island as early as 1855. Between 1864 and 1877 there were about twenty-five crews of gill-net fishermen. In 1879 the fishery began to decline. There was a good catch in 1881, but since that year it has been very poor. There were about ten crews in 1884 and eight in 1885. They have from one hundred and twenty to one hundred and fifty nets to each boat, and fish throughout the summer months and occasionally in winter.

Up to 1873 all the fishing was with gill-nets, but pound-nets were introduced at that time, and three of them were in use up to 1878. From May to August, 1885, two pound-nets were set in Rocky Island passage by a fisherman from Sheboygan. The only other fishing is a little with hand-lines through the ice in winter.

The catch consists of whitefish and trout, with a great preponderance of the former. About 20 per cent. of it was sold fresh to collecting steamers belonging at Escanaba, and the remainder was salted and shipped to Milwaukee and Chicago.

Statistics.—The total amount of property invested in the fisheries of Washington Island in 1885 was $7,980, and the value of the products was about $6,800.

47. NEWPORT TO LILY BAY, INCLUSIVE, DOOR COUNTY, WISCONSIN.

Past importance of fisheries.—The east shore of Green Bay peninsula, from Death's Door to the Sturgeon Bay Canal, is of great historic interest in connection with the fisheries, which were formerly important, though at present its fishing interests are very much smaller than those of the opposite shore.

General features and inhabitants.—The coast waters are generally shallow, but there are several good harbors; North Bay, in particular, is one of the best harbors on the Lakes. The principal industry throughout this region, as in other portions of the Green Bay peninsula, is farming. The German element of the population is larger than any other, though Irish and French-Canadians are numerous, and Scandinavians still more so; at Bailey's Harbor there are a number of Poles.

Fishing centers.—The fisheries along this shore are carried on from North Bay, Little Harbor, Bailey's Harbor, Jacksonport, Whitefish Bay, and Lily Bay. The principal fishing at North Bay about 1860 was with pound-nets; only a few gill-nets were used in 1885. Little Harbor had one crew of gill-net fishermen in 1885. At Bailey's Harbor both pound-nets and gill-nets were employed. The most extensive pound fishery was carried on in 1862, and the gill-net fishery was at its height in 1859. Jacksonport had no noteworthy fisheries till 1862, although fish are said to have been most abundant between 1850 and 1855. Gill-nets were the only form of apparatus in use in 1885 and prior thereto. Extensive seine fishing began at Whitefish Bay in 1845, and continued until the introduction of pound-nets in 1859, when seines were gradually discarded. The locality is famous as being the place where pound-nets were first set in the open waters of Lake Michigan. The pound fishery was at its height between 1859 and 1873, during which time pound-nets were operated almost to the exclusion of other apparatus. Lily Bay, the only other fishing center on this shore, had one crew in 1885 which employed both gill-nets and pound-nets.

Disposition of products.—There are no dealers north of Sturgeon Bay Canal. A small part of the catch is sold fresh to the farmers and others in the vicinity of the fishing stations, but a much greater quantity is disposed of to the firms at Sturgeon Bay, or occasionally to some other dealer, but nearly three-fifths of the entire yield is salted and shipped by the fishermen themselves to Chicago and Milwaukee.

Statistics.—In 1885 there were in the region under consideration 33 fishermen, of whom 25 were engaged in the gill-net fishery exclusively, 5 in the pound-net fishery exclusively, and 3 divided their time between the two. The total amount of capital invested was $8,374, of which $6,159 was devoted to the gill-net fishery and $2,212 to the pound-net fishery. The products amounted to 105,700 pounds of fresh fish, worth $2,391, and 184,700 pounds of salt fish, valued at $5,222. Of the fresh fish 11,200 pounds were whitefish, 65,250 pounds were trout, 27,000 pounds were herring, and 2,250 pounds were other fish; while of the salt fish 64,800 pounds were whitefish, 79,800 pounds were trout, 39,600 pounds were herring, and 600 pounds were other fish. In the previous year the catch consisted of 104,067 pounds of fresh fish, valued at $3,070, and 173,600 pounds of salt fish, which sold for $5,273.

Gill-net fishery.—The total number of gill-net crews in this section in 1885 was thirteen. Jacksonport had four, the largest number; the others were distributed among the settlements of Newport, North Bay, Little Harbor, Bailey's Harbor, Whitefish Bay, and Lily Bay, three of which had one crew each, and three two crews each. The nets used by these fishermen are of ordinary length, generally between 35 and 45 fathoms, but there is a great difference in the depth. Most of them are only 14 or 16 meshes deep, but at Lily Bay several are used with a depth of 40 meshes. At Whitefish Bay the depth of the nets was from 16 to 19 meshes in 1884, and from 19 to 24 meshes in 1885. The size of mesh varies from $4\frac{1}{2}$ to 6 inches. There are a few herring nets at Lily Bay; these have a mesh of from 2 to 3 inches, and are 70 meshes deep. The nets are generally rigged with corks and leads. The fishing is carried on throughout most of the year, except during the winter, when the water is filled with floating ice. At Jacksonport the season is from April 15 to June 20, and from October 1 till about December 10. A majority of the fishermen operate their own apparatus in partnership, but at Jacksonport and Whitefish Bay the owner of the outfit hires his help at from $20 to $30 per month. The gill-net catch at Bailey's Harbor and places further north is about two-thirds whitefish and one-third trout, but at Jacksonport the proportion is 90 per cent. trout, and only 10 per cent. whitefish.

In 1885 there were twenty-five men gill-net fishing, besides three pound-net fishermen who used gill-nets. The number of nets was 867, valued at $4,335. The boats were worth $950, the shore-houses $660, and the accessories $214. The products amounted to 140,900 pounds, worth $4,381, of which 53,450 pounds of trout and 7,950 pounds of whitefish, worth $1,400, were sold fresh, and 61,700 pounds of trout, 26,600 pounds of whitefish, and 1,200 pounds of herring, worth $2,781, were salted.

Pound-net fishery.—In 1859 the first pound-nets were brought to Whitefish Bay, where an important fishery with this kind of apparatus was carried on from that date until 1884. In the latter year three nets yielded 400 packages of fish, which were salted and sold in Chicago and Sturgeon Bay. In the following year, on account of the very great scarcity of fish, these nets were not fished. One net was set near the bay in 1885, but the catch was very small. The decrease in the abundance of fish commenced immediately after 1875, when the fish were so plentiful that 1,400 packages were taken from five pound-nets between July 15 and August 19.

The pound-net was introduced into several other places in the vicinity in the same year that it made its appearance in Whitefish Bay. Bailey's Harbor had one net in 1859 or 1860, and five in 1862, which was the largest number ever used there. In 1884 and 1885 two nets were fished in the bay; these were furnished by a firm at Thayerport, that also provided barrels and salt, and paid the fishermen $1 a package

for filling the barrels with the herring of which the catch was largely composed. North Bay likewise had a pound-net fishery from the time of the introduction of the method, but it ceased altogether about 1878. In 1885 there were only four pound-nets in the entire region; the one not already mentioned was at Lily Bay.

The nets were from 22 to 30 feet deep and about 30 feet square. The leaders were from 891 to 1,056 feet long, and the mesh in the pots was from 2 to 2½ inches. The nets were fished by eight men, and were worth $1,600; the boats, seven in number, being valued at $280, and the shore-houses and accessories at about $335. The catch in 1885 amounted to 44,300 pounds of fresh fish, valued at $691, and 95,300 pounds of salt fish, worth $2,441. Of the fresh fish 27,000 pounds were herring, 3,250 pounds were whitefish, 11,800 pounds were trout, and 2,250 pounds were mixed fish. The salt fish consisted of 38,400 pounds of herring, 38,200 pounds of whitefish, 18,100 pounds of trout, and 600 pounds of other fish.

Seine fishery.—As has already been stated, it was in 1845 that seines were first used in Whitefish Bay, from twenty-five to thirty men being employed each season, until 1859, when the seines were replaced by pound-nets. As many as 3,000 packages of suckers were sometimes caught in a single season with two seines. In North Bay also the coming of the pound-net put a stop to seine fishing, which had there been carried on for several years. The height of the fishing at North Bay was just prior to the advent of the pound-net. For many years there have been no seines whatever fished in the whole district.

48. HORN'S PIER, DOOR COUNTY, TO NERO, MANITOWOC COUNTY, WISCONSIN.

Physical characteristics.—Along this coast the shores are generally high, and the water, except in the vicinity of Ahnapee, is very shallow and in many places is only a few feet deep at considerable distances from the land. Between the Sturgeon Bay Canal and Ahnapee a sandy flat from a few rods to half a mile wide intervenes between the water-line and the high bluff which runs parallel to the shore; but south of it the highlands usually extend out to the water's edge. The only natural harbor between the canal and Two Rivers is at Kewaunee. The lake bottom on this coast is clay, and the lack of harbors is partially compensated for by excellent anchoring grounds.

Population.—The inhabitants of this region are principally Germans and Bohemians, the latter element greatly predominating around Kewaunee, but being almost absent in Ahnapee and vicinity. There are a few Norwegians between Kewaunee and Nero, and they largely predominate between Sturgeon Bay Canal and Foscoro. Nearly all the people are engaged in farming.

General description of the fisheries.—The only fishery of importance in this entire region is that with gill-nets. These are used in greater

or less numbers at Horn's Pier, Clay Banks, Ahnapee, Kewaunee, Sand Bay, and Nero, by professional fishermen and farmers. The only other fisheries are a little pound-netting at Clay Banks, unimportant seine fishing at Carlton and Kewaunee, and dip-net and trammel-net fisheries carried on by farmers in the Kewaunee River.

Statistics.—The total number of men employed in the fisheries and in the fish trade in 1885 was 69, with a capital of $29,678, of which $16,520 was invested in the gill-net fishery, and $1,158 in the pound-net, seine, and minor fisheries. The products in the same year amounted to 512,840 pounds, worth $19,098; this quantity was almost all trout, there being only 1,800 pounds of whitefish and 22,240 pounds of other fish. Of the total catch, 54,900 pounds of trout and 800 pounds of whitefish, valued at $1,790, were salted. The fishermen sell their catch to dealers at Green Bay or at Ahnapee. The amount of capital invested in the fish trade at Ahnapee was $12,000, including $8,000 for shore property, $1,000 for accessories, and $3,000 for floating capital.

Gill-net fishery.—This region was settled about 1855, since which time there has been a gill-net fishery of more or less importance. At Kewaunee, where there was only one crew in 1885, there were about twenty crews in 1860, when the fishery was at its height. At Nero, where in 1885 there was no regular fishing, there were over a dozen crews five years earlier. Nineteen crews constituted the total number in 1885, twelve being in Ahnapee and vicinity, where the fishery was more important than ever before. Besides these there were about ten farmers at Nero and Sand Bay, who had one or two nets each, fished occasionally for their own use. Most of the professional fishermen, including all of those at Ahnapee, fish from about May 1 to December 1. The exceptions are several who discontinue operations for two or three months in the summer. There has never been much winter fishing, though in the winter of 1883–'84 there was a steamer from Ahnapee employing gill-nets.

The nets used are of ordinary size and make, rigged with cork and lead. The boats are chiefly mackinaws. A small steamer, the *Commodore Nutt*, began fishing from Clay Banks in the fall of 1885.

The number of men in this fishery in 1885 was 43, including 1 pound-net fisherman who devoted a portion of his time to gill-net fishing, besides 10 farmers who fished only occasionally and on a very small scale. The number of nets was 1,597, valued at $7,995; the number of boats was 23, valued at $1,830, besides a steamer of 4.60 tons, worth $2,500, and the value of shore-houses and accessories was $4,200. The products amounted to 448,800 pounds of trout, 1,800 pounds of whitefish, and 1,000 pounds of mixed fish, making a total of 491,600 pounds of fish, bringing $18,553, of which 54,900 pounds of trout and 800 pounds of whitefish, with a value of $1,790, were salted.

Pound-net fishery.—Pound-nets have been fished here for many years, but never in any great numbers. There were never more than two

at Kewaunee, and those were in use between 1866 and 1870. Ahnapee at that time had about the same number. At Nero there were several pound-nets at various times between 1860 and 1875. In 1885 the only pound-nets between Horn's Pier and Nero were two—a small one, in 14 feet of water, at Clay Banks, and another in 16 feet of water, a mile north of that place, both of which were fished for the first time in that year. The only fish taken were herring, which were sold both fresh and salted. A portion of the catch prepared in the latter way was disposed of in Manitowoc and a part of it was put up in 16-pound kits and sold to the farmers in the interior at from 75 cents to $1 each. It is stated that the pound-nets used at Ahnapee many years ago were deep enough to catch trout and whitefish, and that there was a noticeable proportion of the latter species, which of late years has been taken only in very small numbers along this shore.

The two nets referred to were operated by four men, and had a value of $450. The small skiffs used in fishing them and other accessories had a combined value of about $80, and the shore-houses were worth about $350. The products in 1885 amounted to 1,000 pounds of fresh herring, worth $20, and 5,440 pounds of salt herring, which brought $192.

The seine and other fisheries.—One very small seine at Carlton was fished in the spring of 1885 for suckers and herring for home use, and one at Kewaunee was used in the same season for catching perch. The value of the two seines was only $30, and of boats and accessories $40. On the Kewaunee River six or eight farmers employed trammel-nets, or dip-nets, for suckers and allied species, which were used locally. The trammel-nets were from 50 to 100 feet long and 20 or 24 meshes deep; the mesh of the netting on the outside being 7 inches, and that on the inside from 4 to $4\frac{3}{4}$ inches. This fishing was confined entirely to the river, and the nets have never been set in lake waters.

49. MANITOWOC COUNTY, WISCONSIN.

Fishing centers.—The settlements in Manitowoc County from which fishing is carried on are, in addition to Nero, which was considered in the former section, Two Rivers, Manitowoc, and Hika. In 1885 the first named place had a population of 2,100, of whom 300 derived their support from the fisheries. The 8,000 inhabitants of Manitowoc are only slightly interested in fishing, although the place is an important shipping and ship-building center. The fisheries of Hika have sprung into existence since 1884; they are as yet unimportant, only six men devoting their attention to this business in 1885.

Character of fisheries.—The fisheries of this county are carried on almost exclusively with gill-nets and pound-nets, and more than four-fifths of the fishermen belong at Two Rivers. Several fishing steamers have been used in the county in earlier years, but in 1885 no vessels of any kind were employed in the fisheries. Seines, fyke-nets, and set-lines are also in use but only on a very small scale.

Species.—Nearly six-sevenths of the fish caught in this region are trout, and the remainder of the catch consists mostly of whitefish. There is an insignificant amount of pike, pickerel, sturgeon, and perch in the catch of the Two Rivers pound-nets, and a few herring are obtained by the fishermen at Manitowoc. Lawyers and suckers are caught in the pounds, but the former are invariably thrown away, and the latter are never marketed, though sometimes eaten by the fishermen.

Trade.—There are two firms of fish dealers at Two Rivers who handle a considerable portion of the catch of the local fishermen. Most of the products are now sold fresh, although some are smoked, and in 1885 a considerable quantity were salted. Formerly, nearly the entire yield was salted. The pound-net men always made a practice of putting a small portion of their catch upon the market in a fresh state, but the gill-netters did not begin to sell fresh till 1870. During recent years, as a general rule, only the large trout have been salted.

The following table shows the extent of the fish trade of Manitowoc County in 1885, the figures given representing the quantities of fresh and salt fish purchased by the dealers from the fishermen of this and adjacent regions:

Wholesale fish trade of Manitowoc County, Wis., in 1885.

Species.	1885.		
	Fresh.	Salt.	Total.
	Pounds.	*Pounds.*	*Pounds.*
Whitefish	11,719	....	11,719
Trout	130,379	38,600	168,979
Pickerel	650	....	650
Perch	910	....	910
Sturgeon	2,000	....	2,000
Total number of pounds handled	145,658	38,600	184,258
Value of same	$6,459	$782	$7,241

In 1884 about 9,000 pounds of whitefish and 3,000 pounds of sturgeon were smoked before being placed upon the market, and a proportional amount was treated in the same manner in 1885.

About 80 per cent. of the fish handled are shipped to Chicago and the rest are sold to peddlers, who carry them in wagons through the surrounding country.

Dependent industries.—Between 1864 and 1867 the making of fish barrels was regularly carried on. From six to eight men were employed in this way, making six or seven thousand barrels a year. Recently only one or two hundred barrels have been made annually.

The knitting of nets has been carried on regularly in the region for thirty-five years, most of it being done by girls from eight to fourteen years of age. In the winter of 1882–'83 scores of girls and women at Mishicott, 8 miles from Two Rivers, and at other towns in the county,

occupied themselves in the making of netting for pound-nets. Twenty-three thousand pounds of twine were knitted during the season. In 1884-'85 only 5,000 pounds were utilized. The price received for the knitting is 9 cents a pound for 8-inch mesh, 10 cents for 5-inch mesh, and 11 cents for 4-inch mesh. The workers usually made from 30 to 60 cents per day.

Statistics.—The total number of persons employed in the fisheries of Manitowoc County in 1885 was 70, 3 of whom were shoresmen. Twenty-one gill-net boats, 12 pound-net boats, 9 pile-drivers, and 1 other small boat were used in fishing; also 1,838 gill-nets, 20 pound-nets, 2 seines, 3 fyke-nets, 80,000 feet of set-line, and 1 cast-net. The value of floating property was $2,850, apparatus of capture $20,400, shore property $2,830, accessories $900, and cash capital $2,000. The products consisted of 29,200 pounds of fresh whitefish, 2,000 pounds of salt whitefish, 240,000 pounds of fresh trout, 42,700 pounds of salt trout, 1,400 pounds of fresh pike, 2,800 pounds of fresh sturgeon, 5,125 pounds of fresh herring, 500 pounds of salt herring, and 3,300 pounds of fresh perch and other fish, the whole having a value of $13,200.

Pound-net fishery.—The first attempt at pound-net fishing within the limits of Manitowoc County was made in 1861. The original net was of the old-fashioned type, without a tunnel, and the results were so discouraging that it was soon taken up. In the following year two pound-nets were brought from Green Bay and set in Manitowoc Bay near Two Rivers. This experiment was so successful that at times three boat-loads of fish were taken out daily without emptying the nets. In 1862 other parties set two additional pound-nets in the same vicinity. The fishery grew rapidly, until in 1865 there were more than thirty-five nets on the shores of the county, and this number was maintained until 1869 or 1870. Still later there was a further increase, and the business reached its height in 1881, when there were between fifty and sixty pounds.

There were in 1885 eight crews of pound-net fishermen in the county, each containing two men and fishing two or three nets set in a single string. One crew was at Manitowoc, one at Hika, and the others at Two Rivers. In 1884 there were two crews with five nets at Manitowoc.

The nets used vary from 26 to 48 feet in depth, averaging 38 feet. The leader is usually 1,135 to 1,320 feet in length, though sometimes less than 600 feet, and has a mesh of 7 to 9 inches. The hearts have a 6-inch and the pots a 3-inch mesh; the funnel is about 14 feet long. In the construction of a pound of fair size there are required about 500 pounds of twine, costing 25 cents a pound, 45 stakes, worth $100, $40 worth of hanging lines, and 2 barrels of tar, valued at $5 per barrel. The labor of knitting the nets costs 12 to 15 cents per pound, and the stringing costs $30.

The pounds are put into the water between the 15th of May and the 10th of June, are fished through the summer without intermission, and are taken out between the 10th of September and the middle of October.

About seven-tenths of the fish caught are trout, nearly one-fifth whitefish, and the remainder principally sturgeon, perch, and pickerel.

In 1874 the catch was unusually large, and two-thirds of it was salted, but since that year it has usually been sold fresh. In 1881 the stock amounted to $1,000 to each net, one-half of which was for whitefish; but the two succeeding years it was only half that amount. In 1884 it had fallen to $400, and in 1885 to less than $200. The decrease in abundance of fish has been to a great extent limited to whitefish, which have rapidly grown scarce since 1879. In 1884 the total value of the product of the pound-net fishery of Two Rivers was $6,381, but this included the stock of two nets belonging to a crew which had withdrawn from the business before the opening of the following season.

Gill-net fishery.—Long before the pound-net fisheries began, gill-nets were fished in these waters in considerable numbers and with great success. As an illustration of the abundance of fish it may be stated that in 1852 there were taken in thirty nets 300 packages of whitefish and 50 packages of trout. Several fishing steamers have made their headquarters at Two Rivers, at intervals, since about 1870. In 1872 the steamer *Marion*, owned at Manitowoc, began to operate gill-nets from Two Rivers, but after continuing the practice for seven years she finally went into the dredging business. The *Bertha Endress* fished here in 1883, and then left for Lake Superior. The steamer *Boss*, of Chicago, fished from the place during the season of 1884, but later drifted out of the harbor in a storm and was lost. In 1885 the business was carried on exclusively from small boats.

In 1884 there were at Two Rivers 11 crews, consisting of 24 men, with 1,095 nets. The total value of their boats and apparatus amounted to $8,800. In 1885 there were 16 boats, with 34 men, and 1,750 nets, the boats and nets having a combined value of $13,400. The products in 1884 amounted to 50,877 pounds of fresh fish, worth $2,900, and 400 packages of salt fish, valued at $1,160. In 1885 they consisted of 146,000 pounds of fresh and 427 packages of salt trout, with a total value of $7,800.

The season usually begins about March 15, but in 1885 the fishermen were not able to start until the middle of April. About the 20th of September they go north, usually to Ahnapee or Clay Banks, and work there until November 30. Some of the boats work on the Newtonville reef, 1 mile from shore, from October 1 to December 1.

The nets used are 45 fathoms long and 18 meshes deep, with a $4\frac{1}{2}$ to $4\frac{3}{4}$-inch mesh. Corks and leads began to be substituted for floats and stones about 1875. Each net contains 7 pounds of twine, 53 pounds of leads, 1 pound of sewing twine, 10 pounds of "meter" or hanging rope, and 160 floats. The leads cost 10 cents per pound, the sewing twine 25 cents, and the other twine $1.85.

The fishing grounds are 4 to 12 miles off the harbor on a clay bottom, in from 12 to 70 fathoms of water. The shoal water fishing is done only in summer during the spawning season of the trout. The catch consists entirely of trout. Whitefish were formerly the principal object of pursuit, but the gill-net fishermen began to find them scarce twelve or fifteen years ago, though the pound-net men did not suffer from the decrease until much later, and even yet catch a good many during certain portions of the season. Before 1870 all of the catch was salted, and afterwards it continued to be the custom to salt most of the fish taken while fishing at the north in the fall, with the exception of a few marketed at Ahnapee.

Other fisheries.—Twenty years ago there was considerable fyke-netting, but the fishery has declined since that time. Grounds that would otherwise be suitable for seining have been spoiled by mud dumped from dredges, so this fishery is likewise neglected. Seining was extensive at one period, but in 1885 only two small seines were in use in the county; these took whitefish. Ten thousand hooks, on trawls, were fished from three boats in the fall of 1885, this being the most extensive trial ever given to this form of apparatus in this vicinity.

50. SHEBOYGAN COUNTY, WISCONSIN.

Geographical description.—The shore line of Sheboygan County is about 25 miles in extent. Its contour is slightly undulating, and hardly broken by the mouths of the two streams which flow into the lake at or near Sheboygan. The only places where fisheries are in existence are Sheboygan, Oostburgh, and Cedar Grove. Sheboygan is a city of 8,000 people, and the seat of an important gill-net fishery with steamers and sail-boats. Oostburgh is a village of 300 inhabitants, whose pound-net fisheries give employment to more than twenty men who, with their families, constitute over a third of the population. Cedar Grove is of about the same size as Oostburgh, and, like it, participates, though to a smaller extent, in the pound-net fishery.

Character of the fisheries.—The pound-net fishery of Oostburgh and Cedar Grove, the steamer fishery of Sheboygan, and the shore gill-net fishery carried on by the crews of the steamers when their vessels are not running, constitute the entire fishing industry of the county, the occasional set-line and cast-net or "plunk-net" fisheries being too insignificant to merit attention. The steamer fishing is wholly with gill-nets, though set-lines were used to a considerable extent some years ago.

Species.—A noticeable feature of the fisheries of this region is the great predominance of the blue-fins over the ordinary variety of whitefish. This result is due to the fact that the gill-netters fish chiefly in the deep portion of the lake, which is the favorite resort of the blue-finned variety. Their catch of whitefish consists of 98 per cent. of blue-fins, although the other fishermen get chiefly the typical variety. The

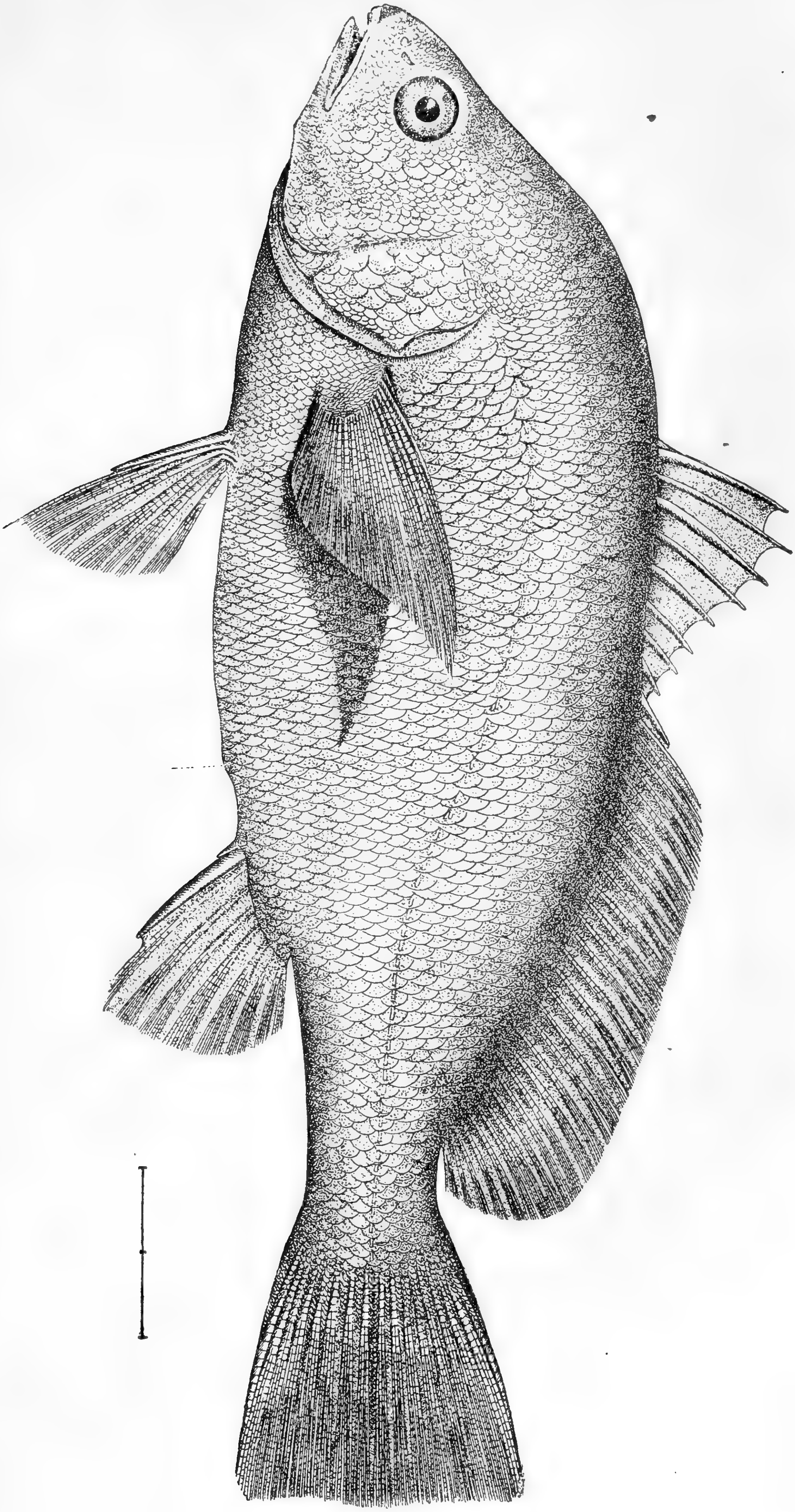
proportion of blue-fins to common whitefish in the total catch is as nine to one. While the steamers catch blue-fins almost exclusively, with only a few trout, the shore gill-net fishery produces a large percentage of trout, with only a small admixture of whitefish and blue-fins, and the pound-net catch is principally trout, with considerable quantities of whitefish and herring and a few other species. The trout average 3 or 4 pounds each, though they are often taken weighing as much as 7 or 8 pounds. The abundance of the herring has remained unchanged since the earliest times of which any record has been retained.

Trade.—Prior to 1867 all the products of the fisheries were salted, but one firm began selling fresh fish that year and since 1868 very few have been salted, most of the catch being sent fresh to Chicago and Milwaukee, and a considerable quantity of blue-fins and sturgeon being smoked before shipment. The smoking of fish began with a series of experiments about 1863 which were so successful that the business has been steadily on the increase. Formerly large quantities of fish oil were made annually, but only about 100 gallons were saved in 1885.

The following table shows the quantity of fish handled in Sheboygan during 1884 and 1885:

Species.	1884.	1885.		
	Fresh.	Fresh.	Salt.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*
Whitefish	37, 000	11, 920		11, 920
Trout	174, 200	130, 200	38, 600	168, 800
Pickerel	500	650		650
Perch		1, 000		1, 000
Sturgeon	10, 000	2, 000		2, 000
Total number of pounds handled	221, 700	145, 770	38, 600	184, 370
Value of same	$11, 850	$5, 700	$1, 800	$7, 500

Statistics.—There were 87 men, most of them professional fishermen engaged in the fisheries of Sheboygan County in 1885. In addition, there were 5 shoresmen employed by the owners of the steamer fishery. Five steamers, worth $19,200, were used in the off-shore gill-net fishery; 8 pile-drivers, and 43 sail and row boats were engaged in the gill-net and pound-net fishing, and had a value of $4,900. The apparatus of capture consisted of 2,028 gill-nets and 38 pound-nets, besides a plunk-net and 4,100 set-line hooks, the total value of which was $32,470; while that of buildings and wharves amounted to $18,600, and of fixtures and accessories to $6,500, the cash capital being $3,525. The products in 1885 consisted of 336,720 pounds of fresh blue-fins, 3,700 pounds of salted blue-fins, 18,000 pounds of smoked blue-fins, 37,000 pounds of fresh whitefish, 13,200 pounds of salted whitefish, 392,215 pounds of fresh trout, 14,300 pounds of salted trout, 3,000 pounds of pickerel, 6,000 pounds of fresh sturgeon, 7,050 pounds of smoked sturgeon, 31,550 pounds of herring, and 3,500 pounds of other fish. The total value of the products to the fishermen was $52,800.



SHEEPSHEAD (*Aplodinotus grunniens*).

Pound net fishery.—The first pound-net in Sheboygan County was brought from Manitowoc by a Norwegian fisherman, and set near Sheboygan Harbor in 1863, and in the same year another was put in near Oostburgh. The nets first used were 30 feet deep, but in 1865 were altered to 40 feet. The nets now in use are from 24 to 64 feet deep, averaging 47 feet. The length of the leader is usually about 1,237 feet. The fishermen begin to set their nets about May 1, and by the middle of June all the nets which are to be used during the season have been put in place. They are not taken up, except for washing, until October 15, unless they are blown out by storms, as frequently happens even as early as September 10.

In 1865 the catch was 95 per cent. whitefish, and the rest trout, with a few sturgeon and herring. In 1870 and 1871 the fishing was poor, but in 1873 the yield was again good, and the stock obtained from two nets was $1,100 worth of fresh fish and $3,000 worth of salt fish. Those salted sold at $5 a package and the fresh at 3 cents a pound. The fishery declined again till 1879. In 1880 the fishing improved; in that year one of the crews obtained $4,200 worth of fish from three nets, in 1881 the same amount from six nets, and in 1883 $3,000 worth from nine nets. Whitefish which formerly constituted 90 per cent. of the entire catch have been only a small element in it during recent years.

In 1885 there were eight crews of pound-net fishermen in the county, two of them being at Cedar Grove and six at Oostburgh. The proportions of their catch in that year were 55 per cent. trout, 18 per cent. whitefish, 17 per cent. herring, 8 per cent. sturgeon, and 2 per cent. perch.

Gill-net fishery.—The gill-net fishery of the county is limited to the town of Sheboygan. In 1885 it was carried on by the crews of five steamers owned at that place. Gill-nets were fished there regularly with sail-boats as long ago as 1852, but sail-boat fishing never became extensive. Steam fishing was first introduced in 1872, when the steamer *Kittie Gaylord*, of Milwaukee, made Sheboygan its headquarters for about two months. The steamers *Hoffnung* and *Maggie Lutz* were built for the business in the following year. The steam-vessels in use in 1885 were the *Hoffnung*, *Fritz Karste*, *J. N. Brooks*, *Carrie May*, and *Minnie Karl*. The total tonnage of this fishing fleet was 64.05. The fishing is carried on the year round, but the steamers lay up from about the last of June to the middle of September, when they are replaced by a number of sail-boats manned by members of the steamers' crews. The favorite ground for the steamers is the "Mud Hole," 20 miles east of Sheboygan. It is 7 or 8 miles square, and the water is about 90 fathoms deep. In the spring the steamers run to the southward and later in the season to the north.

The nets are about 50 fathoms long. Each steamer has from six to fifteen gangs of seven or eight boxes each; a box contains six nets, with a value of $6 or $7 apiece.

The catch in the Mud Hole is mostly whitefish of the variety known as black-fins, or, more frequently in this locality, blue-fins. In the sail-boat fishing the catch is 86 per cent. trout, a little less than 6 per cent. common whitefish, and 8 per cent. blue fins.

The average catch of the steamers in 1884 was 85,100 pounds. In 1885 it was 65,800 pounds of fresh blue-fins, 32,500 pounds of fresh trout, and 400 or 500 pounds of fresh whitefish, besides 18,000 pounds of salted fish, and 13,000 pounds of smoked fish.

Other fisheries.—No forms of apparatus were used in 1885 except those already mentioned. About 1876 or 1877 there was some sturgeon fishing from sail-boats with hooks baited with minnows. At times minnows have been taken with dip-nets to be used as food. About 1878 trawls were set in the fall and winter by several of the crews of the steamers fishing later with gill-nets; and about 1880 one boat caught trout on set-lines baited with small herring and blue-fins during the spring months. Seine fishing flourished between 1850 and 1865, but there has been none since 1870. Trammel-nets have been rather extensively employed in earlier times, but for many years none have been used.

51. OZAUKEE COUNTY, WISCONSIN.

Location of the fisheries.—Although the shores of Ozaukee County are of about the same extent as those of Sheboygan County, their population is much less extensive and the fisheries are quite insignificant.

There are several small hamlets near the lake, but in 1885 the fishing was confined to Port Washington, the county seat, a town of 1,500 inhabitants engaged in various manufacturing industries. Five years ago there was one pound-net in the scattered farming community surrounding Mequon post-office, and some of the farmers there have single gill-nets with which they fish for suckers in spring, merely for home supply.

Pound-net fishery.—The only regular fishery of the county is with pound-nets. The first apparatus of this sort was set in the year 1865. The fishery reached its height in 1870, when there were eighteen pound-nets owned in the county. In 1881 there were fourteen pound-nets, but the business rapidly declined, so that in 1885 there were only two crews with four nets.

The nets are set about June 10 and taken up the middle of August. Nearly nine-tenths of the catch is trout, and the remainder is three-fifths whitefish and two-fifths sturgeon. The value of the pound-net catch in 1884 was $1,800; about one-fifth of the product was shipped to Chicago. In 1885 the stock was only $925.

Gill net fishery.—There was considerable gill-net fishing prior to 1879, but since that time it has been quite unimportant. The nets used are 45 fathoms long and 20 meshes deep, and cost $5 each. Seventy nets were used in the winter of 1884–'85, the catch being nine-tenths whitefish, and selling at 8 cents per pound.

Other fisheries.—One seine was fished occasionally for pickerel and suckers, and there were also several gangs of set-lines with one thousand hooks each.

Disposition of products.—The products of the fisheries are generally sold in a fresh state. No oil or caviare is made, and only about 1,000 pounds of fish were smoked in 1885.

Statistics.—In 1885 there were only 11 fishermen in the county, using 7 boats, worth $335, and apparatus of capture worth $3,365. The value of buildings and accessories was $420. The products consisted of 5,500 pounds of whitefish, 30,000 pounds of trout, 2,000 pounds of pike and pickerel, 1,500 pounds of sturgeon, and 3,000 pounds of other fish, the whole having a value of $1,500.

52. MILWAUKEE COUNTY, WISCONSIN.

Character of the fisheries.—Although this county has a shore-line of about 30 miles, its fisheries are carried on entirely from the city of Milwaukee, with the exception of small interests at Whitefish Bay. Milwaukee is one of the most important commercial centers on the Great Lakes, and its fisheries form no inconsiderable part of the business of the place, those with trawls and gill-nets from steamers and sail-boats being especially important. A number of other forms of apparatus have been used to a greater or less extent, including pound-nets, seines, trammel-nets, fyke-nets, dip-nets, and baskets; an attempt was even made to employ the British beam-trawl, which, however, proved a failure.

In 1885 all of the leading fishermen were Germans, with the exception of a single family of Hollanders. They may be divided into three classes—the steamer fishermen, the shore gill-net fishermen, and the miscellaneous shore fishermen.

Off-shore fishing grounds.—Most of the gill-net fishing is carried on upon the two great reefs which skirt this portion of the coast. The inner reef is 20 miles long, and extends from Racine to the North Point. Its outer edge is about 10 miles, and its inner edge 5 miles from the land. The water is from 10 to 17 fathoms deep, and the bottom is generally rocky, with occasional patches of clay. The outer reef begins east of the city near the land, and runs first northeast and then north-northeast, extending as far north as Sheboygan, at which point it is 18 miles from shore. It is about 4½ miles wide and about 35 fathoms deep, with a bottom of varying character, in some places pebbly, in others rocky, and in others covered with clay or black sand.

Shore fishing.—Besides the crews of the steamers fishing with gill-nets and set-lines and the men fishing gill-nets from sail-boats, there are a number of men who give their attention to netting suckers and dipping minnows in the late winter; they also fish with seines for shore species in summer, and with fish-baskets for crayfish throughout the season of open water. Occasionally they occupy themselves in the first few

weeks of winter with fyke-net fishing under the ice. This class of men do much of their fishing, especially that for crayfish, in the broad marshes which flank the mouth of the Milwaukee River for several miles. Apart from the crayfish, the river fisheries have ceased to be productive as the water has become so polluted that very few fish now enter it. With one exception the gill-net fishermen have their shanties on an island in Milwaukee Harbor.

Decreased abundance and size of fish.—In the early days of the Milwaukee fisheries the catch was half whitefish, except in autumn. There has always been considerable fluctuation in the abundance of this species. In 1870 the whitefish were growing scarce rapidly, and those taken were of small size. In 1874 almost none were taken by the steamer fishermen, but in 1881 they constituted for two or three months of the year from one-third to one-half of the catch. The fishermen think that the severe storm which took place in that year drove them over from the eastern side of the lake. Since then they have been very scarce again, and in 1885 less than 6 per cent. of the entire catch was whitefish. It is supposed that the reef has considerable influence in preventing the whitefish from coming in shore. The water between the reef and the shore is nowhere deeper than 10 fathoms. There has been some change in the yield of trout in the last few years. In 1885 this species comprised nearly three-quarters of the entire yield of the fisheries. In 1871 the steamer fishermen set their nets around the reef, and if in any instance a net was placed on the reef the trout taken were large ones, weighing 8 to 15 pounds. As late as 1875 no trout weighed less than 6 pounds. Of late years the fishing has been wholly on the reef, but only greatly reduced quantities of fish have been obtained, and these have been of small size, averaging only about 3 pounds each, and those of 6 to 10 pounds have been only occasionally taken. Sturgeon were formerly abundant, but during the decade from 1875 to 1885 have been very scarce. In 1884 the entire fleet of gill-net and set-line fishermen obtained only five of this species averaging 50 pounds apiece. Herring are more numerous than any other species, but are not usually saved.

In consequence of the growing scarcity of the more important species there has been a considerable decrease in the general productiveness of the fisheries, and the fishermen were unanimous in their complaint that the season of 1885 was one of the poorest ever known, some of them not being able to stock enough to pay expenses.

Disposition of products.—Over 80 per cent. of the fish caught by the steamer and set-line fishermen are packed in ice and shipped by the fishermen themselves to Chicago, usually by rail. The charges to the railway station at Chicago amount to 20 cents a box, and are paid by the buyer. They net the fishermen 7 or 8 cents a pound in winter, but in summer sometimes are as low as 3 or 4 cents, so that the average for the year would be only about 5½ cents. The whitefish bring 7 cents a

pound when the trout and sturgeon are selling for 5 cents. The steamer fishermen have their own ice-houses, and in winter cut enough ice to last them through the next fishing season. Only one of the steamers disposed of its catch in Milwaukee, the others selling in Chicago. All but one of the sail-boats, on the contrary, sold locally.

The miscellaneous fishermen ship their crayfish to Chicago and the eading cities of the East, but the perch, lawyers, suckers, and eelpouts are peddled about the streets of Milwaukee.

Trade.—Twenty-five years ago Milwaukee furnished the entire supply of fishing products for Chicago, as well as for the home market. In recent years there have been four principal dealers who buy directly from the fishermen and from shippers in all parts of the lakes, and handle on an average about 30,000 pounds of fish a week, only one-sixth of which is sold locally, the remainder being shipped chiefly to towns in Wisconsin, Minnesota, Iowa, Illinois, and Missouri. Each of the firms has from one to five teams, which are used both in peddling and collecting fish.

The smoked fish business.—The smoking of fish is a noticeable feature of the Milwaukee trade. This practice has existed in the city from its earliest days, and is said to have been introduced by a Prussian, who shipped fresh fish to Chicago and smoked small fish for local consumption. The business is more important than ever before, and is still growing. The fishermen do not usually smoke their own fish, but turn them over to the smoke-houses, of which there are eight or nine located on an island near the fishing camps. Several of them belong to the same firms by which the fresh fish trade is carried on. These ship half of their smoked fish to the West and South, but the other smokers sell their entire output in Milwaukee and its environs for immediate consumption. The buildings devoted to smoking are usually small brick or wooden structures, worth about $50 each, exclusive of the land on which they are.

Most of the smoking is done between May and November. During this part of the year each house prepares from 250 to 2,000 pounds weekly. Several smokers confine their operations entirely to four months in the summer, and those who continue during the winter do not smoke over a ton a month. About half of the fish smoked are sturgeon, 8,000 or 10,000 pounds are herring, and the rest trout and whitefish in equal proportions. Most of the sturgeon for smoking are brought from Green Bay, Detroit, and Frankfort, the whitefish from various places on the eastern shore of Lake Michigan, and partly from the local seine fishermen, and the trout from the local line and gill-net fishermen, who usually in this way dispose of their soft fish which would otherwise be unsalable.

The price received for the smoked sturgeon at wholesale is 12½ cents a pound, and for whitefish and trout 10 cents. The fish lose one-third of their bulk in process of smoking.

Statistics.—The number of persons employed in the fisheries of Milwaukee County in 1885 was 145, of whom 94 were fishermen, and the rest shoresmen and preparators. These represented a directly dependent population of between 500 and 600. In addition to the 7 steamers, with a value of $20,500, there were 7 gill-net boats, worth $1,230, 2 pound-net boats, worth about $115, and 12 other boats, worth about $250. The apparatus of capture consisted of 4,796 trout gill-nets, 80 herring and sucker gill-nets, 2 pound-nets, 12 haul-seines, 1,500 crayfish pots or baskets, and about 168,000 feet of set-lines, besides a number of dip-nets and a few fykes and trammel-nets. The total value of the apparatus of capture was $23,000; of buildings and shore property, $33,800; of accessories and fixtures, $9,000; and cash capital, $17,000. The products consisted of 37,750 pounds of fresh whitefish, 300 pounds of salt whitefish, 690,600 pounds of fresh trout, 9,700 pounds of salt trout, 1,500 pounds of pike and pickerel, 1,200 pounds of sturgeon, 32,900 pounds of fresh herring, 300 pounds of salt herring, 60,000 dozen of crayfish, 50,000 pounds of eel-pouts, 45,000 pounds of lawyers, 73,000 pounds of perch and bass, and 200,000 minnows, the whole having a value of $46,300.

Gill-net fishery.—The first regular fishery with gill-nets seems to have been in 1846 or 1847. In 1852 about a dozen sailboat crews were fishing with gill-nets. Each crew contained four men besides one who remained on shore to dry and mend the nets. The fishing outfit of one boat was six gangs of eighteen nets each, three gangs of which were kept in the water, one in the boat, one was drying, and one was being mended in the shanty. The nets were of the same length and nearly the same mesh as in later years, but the twine was coarser.

The catch consisted entirely of whitefish, except on the reefs, where trout was the only species obtained. The average amount of fish taken at a lift was from 1,500 to 2,000 pounds, and the largest catches were about 3,000 pounds. In 1854 and 1855 whitefish were exceedingly abundant and in the latter year the fishery reached its height, no less than thirty-three crews then being employed. Whitefish were then selling at $13 or $14 a barrel.

The products were, at the outset, sold in the local market, but soon the fishermen began to take their fish in boxes on the steam-boats to Chicago and peddle them in the streets of that city.

In 1857 the fishermen, who had previously fished on the inner reef in 15 fathoms of water, began to frequent the outer one instead. In 1858 the railroad entered the city, and shortly afterwards ice began to be used for the first time in the preservation of fish. In bad weather the shipments were made by rail instead of by steamer. About that time, however, the fishing began to decline and one after another the fishermen left for Kenosha, Grand Haven, and St. Joseph, especially the latter point, until the number of crews was reduced to three. After about five years the number increased to four. Since 1869 there have

been occasional fluctuations in the number of crews, but in 1884 it was still four. In 1885 there were three new crews in the city, making a total of seven. Each of them had five or six gangs of net, of from twenty-four to thirty each, but only three or four gangs are kept in the water at a time.

Probably the first steam-vessel used in the fisheries of the Great Lakes, with the exception of a sail-boat at Kenosha into which a small boiler was put in 1867, was the *Kittie Gaylord*, which was built at Washington Island in 1869. The first year she was an open boat, and ran at the entrance of Green Bay; later a deck was put on her and afterwards a pilot-house and wheel. After operating for short periods from Two Rivers and Sheboygan, the vessel finally went to Milwaukee, and thus inaugurated the steam-fishing which has since been a characteristic feature of the fisheries of that city. One by one other steamers were added to the fleet; in 1873 there were five such vessels, and in 1885 the number had increased to seven, the names and tonnages of which were as follows: *L. A. Schultz*, 15.91 tons; *Pottawattomie*, 11.78 tons; *Elva A. Eaton*, about 5 tons; *Maria B. M.*, 14.26 tons; *Dan Costello*, 19.52 tons; *G. R. Green*, 12.27 tons, and *Emma Dwyer*, 25.71 tons.

The products of the steamer fishery in 1884 had a total value of $35,133, but in 1885 they amounted to only $29,625.

When this fishery began the outfit consisted of eight or nine gangs of nets, with forty nets in a gang, but in 1885 most of the steamers carried twelve gangs, with fifty or fifty-two nets each. Six of the gangs are kept in the water while the others are drying on shore. The nets range from 220 to 280 feet in length, the longest being used by the steamers. They are usually about 16 meshes deep, with a 4½-inch mesh, and cost $6 or $7 when new. They wear out in two years, and are then sold to the sucker and perch fishermen. It is not customary to tar them, but in hot weather they are repeatedly scalded.

Each steamer carries three herring-nets, 30 fathoms long, with a 2-inch mesh. They are set at night usually in 55 or 60 feet of water, just inside of the other nets, and as soon as they are lifted the herrings are used in baiting the set-lines. A good many "long-jaws" are taken in the herring-nets, often one hundred and fifty to a lift.

The nets are set on a reef running out towards the middle of the lake. The steamers fish farther from the shore than they formerly did, and the sail-boats now set their nets on the grounds which the steamers frequented in earlier years.

No offal is ever left on the fishing grounds. The spoiled fish are brought to the city and thrown into the river, after being pricked so that they will sink. The men never dress their fish on the fishing grounds.

The catch of the steamers is almost entirely trout, but the sail-boats get in addition about 5 per cent. white fish. The steamer fishermen obtain a few whitefish in spring and fall, and an occasional one in sum-

mer, besides taking twenty to thirty lawyers at each haul of the net. At rare intervals a sturgeon is obtained. Three or 4 tons of eel-pouts are annually sold to the Polish portion of the population of Milwaukee.

A few herring-nets, about half the length of the nets used on the steamers, are owned by the seine and set-line fishermen. Two of them are fished by each crew. Old herring-nets that have been made over are used in small quantities by the sucker fishermen, in the open lake in spring and under the ice in winter. The same men devote their attention to minnow-seining and perch-hooking during the summer.

Set-line or trawl fishery.—This method was introduced from Sheboygan in 1874, and large catches are reported to have been made at the very beginning of the fishery. Since that time, set-line fishing has been carried on regularly during the summer. Each of the gill-net steamers now carries three or four gangs of two hundred to five hundred hooks each, placed 6 feet apart on the line which is sustained by cedar floats at intervals of 10 fathoms. Some of the steamers employ trawls throughout the year, while others use them only from May to September, and still others confine their fishing to the months of June and July.

The lines are set northeast and east of the reef already mentioned, in 25 to 50 fathoms of water, and are left in place from one to three nights before being visited. Two gangs are always in the water together, and the others on board the vessel. At the beginning of the fishery the hooks were set on the bottom, but failing for three or four successive years to take many fish in that way, the fishermen began the use of long snoods in attaching the hooks to the trawl-line. In 1884 experiments were made in setting the hooks near the surface. The result was not satisfactory, but in the following season the captain of the steamer *G. R. Green*, who had been accustomed to fish surface set-lines for salmon in the Baltic Sea, made a new trial which was so successful that the method was at once adopted by the crews of all the steamers. Herring are used for bait in this fishery. The hook is run through the jaws of the fish, two half-hitches are taken around its tail, and it is then blown up through the mouth so that it will float when in the water and resemble a live fish. Trout is the only species thus caught.

Another set-line fishery is carried on along the beach, for perch and lawyers, by the two dozen men who also use the minnow-seines and crayfish-baskets. The lines are provided with eight hundred or one thousand hooks, and minnows are used for bait. The products of this fishery are sold locally in a fresh condition. The business began about 1877 and has been steadily increasing in extent and importance. It is now followed throughout the entire year except in winter.

Haul-seine fishery.—Prior to 1860 large seines were fished regularly in Milwaukee and big hauls were made. Since then the little fishing of this sort that has existed has been with very small seines operated in connection with other kinds of apparatus. From 1860 up to 1880 there were only three or four seines used in the city, but in 1885

there were six crews of two men each which made a regular business of seining, and they were joined by as many more at times when fishing was attended with particularly good success. The seines are from 100 to 150 feet long and 8 or 9 feet deep, and are hauled on the beach by hand for the capture of minnows, eel-pouts, and young whitefish. The fishing is done in the late spring, summer, and early fall, but principally in the months of June and July.

The minnows taken are used for bait and the young whitefish are smoked. The eel-pouts are peddled about by the wives and children of the fishermen. The average stock for the men engaged in this fishery in connection with the shore set-line fishing in 1885 was $400 for each crew of two men.

Pound-net fishery.—The first pound-net fished on the shores of Milwaukee County was set in 1865. The fishery never attained any importance and has usually been confined to Whitefish Bay, where five nets were the greatest number ever operated at one time. It is stated that but one pound-net crew ever made the city of Milwaukee its headquarters, owing to the unfavorable nature of the adjacent shores.

A single crew of two men operated two nets in Whitefish Bay in the summer of 1885, this constituting the extent of the fishery in that year.

Eighty per cent. of the fish taken were whitefish, 10 per cent. were herring, 5 per cent. were trout, and 5 per cent. were sturgeon, bass, and perch. The value of the catch in 1884 was $1,000, and in 1885, $800. A few hundred pounds were salted, and small quantities were sold fresh locally, but the great bulk of the catch was shipped to Milwaukee.

Fyke-net fishery.—Although formerly of considerable importance, this fishery has of late deteriorated, chiefly on account of the polluted condition of the water flowing from the river at the mouth of which the nets were set. In 1885 a few small fykes, with 4-foot hoops, were fished under the ice by men engaged at other times in more profitable fishing.

In 1866 an attempt was made to employ a fyke-net far out in the lake at the end of a gang of gill-nets. The results were unsatisfactory, owing, it is thought, to the fact that the net had no wings. There seems no reason to doubt that fykes provided with wings and properly weighted to maintain the hoops in a vertical position could be profitably employed on all the lakes in connection with the off-shore gill-net fisheries.

Trammel-net fishery.—Three-ply nets, from 150 to 200 feet in length, were used in this region at least as early as 1852, for the capture of perch and pickerel. They are not known here as trammel-nets, but usually as "plunk-nets" or "pocket-nets." They were set most frequently in the Milwaukee River in a position parallel to the shore, except during the run of suckers, when they were sometimes set across the middle of the stream. There were scores of them operated until about 1880, each fisherman owning three or four of them. In 1885 the fishery had been almost entirely abandoned.

Dip-net fishery.—Dip-nets are used by the sucker and perch fishermen for catching minnows through the ice in the spring. Part of the yield is used fresh as bait on perch set-lines, and the remainder is shipped for sturgeon bait. It is customary for the men to use the dip-nets in the morning and to haul their set-lines in the afternoon.

Ice fishing.—In former years, there was a winter line-fishery for sturgeon of some importance. The business began in 1860, and at first the sturgeon were taken in boat-loads, but it was discontinued prior to 1875. This fishery was carried on chiefly by longshoresmen from small row-boats and improvised sail-boats. In 1885 the only fishing through the ice was that which has already been referred to in the sections on the gill-net, fyke-net, and dip-net fisheries.

Crayfish basket-fishery.—About twenty years ago the attention of the fishermen began to be directed to the immense numbers of crayfish which inhabited the extensive marshes at the mouth of the river, and a few men have fished for them annually since that date. The fishery was for a long time carried on only by three or four men, but in the last few years it has been growing rapidly in importance, and in 1885 gave employment to about a dozen men, also engaged in other minor fisheries, each of whom had from one hundred to one hundred and fifty traps or "baskets."

The fishing begins in the spring as soon as the bottom ice is gone, usually about the middle or end of April, and lasts until the middle of October.

The baskets are made of netting, supported on four hoops of elm or bass-wood, with two funnels opening at the opposite ends. They are 18 inches long and 10 inches in diameter. After being baited with trout-gills gathered by the children of the fishermen, they are set along the sloughs at night, in water from 2 to 12 feet deep, and are lifted in the morning. As many as a hundred dozen crayfish are frequently caught in one night's fishing, the average catch being fifty dozen to a hundred baskets.

The fishermen ship their catch to New York, Chicago, Boston, and Philadelphia. The price received varies from 3 to 12½ cents a dozen, but averages 5 cents a dozen.

Attempt to use a beam-trawl.—About 1873 a beam-trawl was imported from England by Messrs. A. Booth & Sons, and was put to a practical test by Capt. Henry Van Ells. He endeavored to operate it on Lake Michigan from his steamer, but found it impossible to tow the net, since it frequently got caught on the numerous snags that lay on the bottom and stopped the progress of the vessel. It was believed before this that whitefish and trout might be taken in a beam-trawl. But the lack of success on this occasion led to the total abandonment of the attempt which has never since been renewed. It is, nevertheless, possible that this form of apparatus might be profitably employed elsewhere on the lakes unless the bottom everywhere is unsuitable for its use because of the presence of rocks or snags.

53. RACINE, RACINE COUNTY, WISCONSIN.

Relative importance of the fisheries.—The fisheries of Racine County are centered in Racine, a city of 18,000 or 20,000 people, situated on a small river 20 miles south of Milwaukee. The inhabitants of the place are extensively engaged in manufacturing of various kinds, the excellent harbor and two railroads affording good shipping facilities. Fishing has never been a leading industry of the city, although from the earliest times fish have been taken in small quantities for market or for home consumption.

History and present condition of the fisheries.—The only fisheries which were of commercial importance in 1885 were prosecuted exclusively with gill-nets and set-lines. Pound-nets have formerly been employed, but never in great numbers. Twenty years ago a small pound was set near the mouth of the river, but its use was discontinued after two years, and no other similar apparatus was used till 1878, when another net was set in the same place and operated for several seasons; since that time none have been employed. The catch of the pounds consisted largely of perch, suckers, and herring, whitefish failing to approach near enough to the shore to enter the nets. Capt. Peter Marks, who has fished continuously at this point since 1866, states that at that time small seines were hauled on the beach and that there was one crew fishing with gill-nets from a sail-boat. In 1868, a steamer owned elsewhere was chartered by Racine fishermen and fitted out with gill-nets for whitefish and trout, the work continuing but one season. From that time till 1880 no steamers were employed, the fishermen depending wholly upon sail-boats.

During the winter of 1880–'81, however, a steamer which had been employed at other seasons in towing, fished with set-lines and continued in the business the next winter. In the fall of 1884 the fishing steamer *Albatross*, 14.79 tons, was purchased by Racine fishermen, and in the spring of 1885 the steamer *George R. West*, 11.42 tons, was built for fishing from this locality.

Species.—The species occurring at Racine are trout, sturgeon, whitefish, ciscoes (used for bait), and minor fish. Fully 80 per cent. of the catch is trout. Sturgeon and whitefish, which are now very scarce, were formerly taken in considerable quantities, and there was a special fishery for the former species, which occurred in large numbers.

Statistics.—Twenty-five men, in the capacity of fishermen and shoresmen, were engaged at Racine in 1885. They employed steamers and boats valued at $8,205, gill-nets worth $4,043, set-lines and minor apparatus of capture valued at $600, and $5,000 invested in wharves and buildings, $1,200 in accessories and fixtures, and $400 cash capital. The total amount invested in the fisheries was $19,448.

The catch in 1885 was 201,900 pounds, valued at $9,710; the yield in the previous year amounted to 106,000 pounds which sold for $5,030.

This increase in 1885 was chiefly due to the fact that a greater quantity of apparatus was used. As already stated, the catch is mostly trout, 168,600 pounds in 1885 being of this species. There were also 7,000 pounds of sturgeon, 5,000 pounds of whitefish, 6,000 pounds of herring, and 15,300 pounds of suckers, perch, and less important species. About 50,000 pounds of herring, valued at $300, were used for bait in the set-line fishery.

Trawl-line fishery.—Trawls, or set-lines, were introduced about 1873, when the fishermen set them for two or three months in the winter and caught large quantities of trout; since which time they have been regularly used, supplanting the gill-nets in certain instances because less expensive and equally productive.

The two steamers at Racine carried set-lines provided with 17,000 hooks; one of these, the *George R. West*, had five thousand hooks and also a full supply of gill-nets; the other, the *Albatross*, fished with set-lines exclusively. Two small sail-vessels, with three men each, also used set lines, one working two thousand hooks and gill-nets as well, the other six thousand hooks and no other form of apparatus.

Each section of trawl has fifty hooks attached at intervals of about 18 feet. The hooks are baited with ciscoes and the trawls are left in the water three or four days before being hauled. About five hundred or six hundred hooks are examined daily by each crew, the fish being secured and the lines rebaited. Bait is obtained in gill-nets carried by each crew, seventy-eight being the total number used at Racine in 1885. The bait-nets are 200 feet long, 40 meshes deep, with a 2-inch mesh, and cost $6 each when new. It is estimated that 50,000 pounds of herring were utilized for bait in 1885. The herring are impaled on the hooks through the back in such a manner that they resemble a fish swimming naturally, care being taken to avoid the viscera, injury to which causes the fish to turn over and float to the surface with the hook.

Sturgeon fishing with set-lines was at one time a prominent fishery at Racine. It began at least twenty years ago in the harbors and small creeks of the vicinity. The first to engage in it were professional fishermen who, owing to storms, were unable to fish their gill-nets between early in January and the middle of April, and they put in their time to advantage by taking sturgeon during that season. Later, fishermen came from Chicago during the winter months, and engaged in the fishery, and continued in the business for a number of years. The fishery attained its maximum about 1875, soon after which it began to decline and in two or three years was practically abandoned. When the fishery was important, it is estimated by competent authority that fifteen hundred or two thousand sturgeon, averaging 40 pounds each, dressed, were caught annually, nearly all of which were shipped to Chicago, where the price received was from 4 to 7 cents a pound.

Nine men were engaged exclusively in this fishery in 1885, and ten others fished gill-nets as well as set-lines. The length of the lines used

was 450,000 feet, and the number of hooks required was 25,000, the completed lines having a value of $500. The seventy-eight bait-nets were 16,380 feet in length and were worth $468. The steamer *Albatross*, with 12,000 hooks, took 59,000 pounds of trout; the steamer *George R. West*, secured 72,000 pounds of trout with both hooks and nets, of which 24,580 pounds were taken with hooks; one of the small sail-boats got 16,000 pounds with 6,000 hooks, and the other 21,600 pounds with hooks and nets, of which 5,300 pounds were obtained with hooks. The total catch, therefore, including 7,000 pounds of sturgeon not before enumerated, was 111,880 pounds, which were sold fresh for $5,664.

Gill-net fishery.—This fishery is not followed exclusively by any of the Racine fishermen. Two crews, already referred to in connection with the set-line fishery, consisting of six and three men, respectively, operated six hundred and fifty nets in 1885, throughout the entire open season on the lake. The nets were each about 200 feet long and 18 meshes deep, with a $4\frac{1}{4}$-inch mesh. The gill-net grounds are from 10 to 25 miles off shore, where the water is 10 to 60 fathoms deep, and the bottom clay and mud. The nets are set across the current at right angles to the shore in gangs of twenty-five to fifty and about a mile apart. Each crew has four or five gangs in the water at once, one set being lifted each day and taken to the shore to be dried and mounted, its place being filled by a new one. The nets had a total length of 196,000 feet, and were worth $3,575.

The catch consists almost entirely of trout, the average weight of which is 3 pounds. A few blackfins and ciscoes are taken at times. The total yield was 70,720 pounds, of which 63,720 pounds were trout, and the remainder blackfins and herring, all being valued at $3,476.

Other fisheries.—These are of little importance. One seine, 50 fathoms long, worth $40, was fished regularly in 1885 by two men, who received between $400 and $500 from the sale of the perch, suckers, and herring taken. The catch amounted to 19,000 pounds in 1885, which were sold fresh at 3 cents per pound. Three trammel-nets, valued at $20 each, were fished in the spring for perch, suckers, etc., the catch being small and chiefly for home consumption.

54. KENOSHA, KENOSHA COUNTY, WISCONSIN.

Description of the town.—The fisheries of Kenosha County are confined to the city of Kenosha, which has a population of 5,000 and a fine harbor, where many of the largest of the lake crafts have their headquarters. Manufacturing interests engage the attention of most of the people.

Character of the fisheries.—The fisheries are of less importance than formerly, when pound-nets were in use. In 1885 the only fishery of any consequence was with gill-nets, though set-lines, haul-seines, and fyke-nets were used.

Statistics.—Thirty-six men, all of German descent, were engaged in the fisheries in 1885. These employed 3 steamers and 3 small boats valued at $9,142; 1,540 gill-nets, 3 seines, 6 fyke-nets, and 1 trammel-net, valued at $8,710; 31,500 feet of set-lines, with 4,500 hooks, occasionally used by the gill-net fishermen, valued at $70; and $6,000 in wharves, buildings, accessories, and floating capital, the total investment being $23,922.

The catch amounted to 226,700 pounds, valued at $10,728. Of the total yield, 112,600 pounds were trout, 106,000 pounds were whitefish, and the remainder mixed fish, including suckers, perch, and lawyers.

Gill-net fishery.—Prior to 1875 gill-nets were fished from sail-boats, of which there were ten in the town. In that year a steamer was first employed. This was the *Fred. Engle*, a vessel of 14.02 tons, net. Her running expenses were heavy, but in the spring of 1876, the year after being built, she stocked $6,000. In 1884 there were two fishing steamers at Kénosha, and in 1885 another was added. These vessels had a total value of $9,100; they carried in all twenty men, and used fifteen hundred and forty gill-nets.

The crew of a steamer consists of a captain, an engineer who receives $50 per month, and four to six fishermen who are hired at from $45 to $50.

Each steamer carries from four hundred to six hundred nets; these are 36 to 40 fathoms long, when hung, with a mesh varying from 4⅛ to 5 inches, and are worth when new from $7 to $8. A gang of nets numbering fifty to seventy-five is set every day and left in the water for about three days. Three or four hauls are made each week.

Operations begin in February, March, or April, according to the amount of ice in the lake, but sometimes fishing is carried on throughout the year. Trout is the only species caught in winter. Whitefish are found only in small numbers during any portion of the year and after April are usually scarce. The nets are set in 38 or 40 fathoms of water; in spring, about 22 miles from shore; in summer, 10 to 25 miles, and in fall 25 miles.

The largest catch in a single gang of nets in 1884 was 1,400 pounds taken by the *Fred. Engle.* The average haul the same year was 500 or 600 pounds. Three-fourths of the catch of this vessel was taken in the fall and she stocked $3,500 in the year, representing about 90,000 pounds of whitefish and trout. The steamer *L. Q. Rawson* (7.05 tons net) fished only two and a half months in the spring, stocking $2,500. The largest single capture of this steamer was 4,400 pounds.

In 1885 the catch of the *Fred. Engle* amounted to 40,200 pounds, worth $1,608, of which yield only 200 pounds were whitefish. The *L. Q. Rawson* fished off Frankfort, Mich., during a portion of the year, taking 170,000 pounds in the season, valued at $8,500. The steamer *Annie L. Smith* (20.15 tons net) engaged a short time in the fishery that year, making but twenty-eight hauls and then discontinuing the business.

The capital invested in this fishery in 1885 was $23,570, of which $9,100 was for steamers, $8,470 for gill-nets, and $6,000 for shore property, accessories and fixtures, and floating capital. Eight shoresmen were also employed in the fishery, in addition to the fishermen already referred to. The catch in 1885 amounted to 208,600 pounds, of which 106,000 pounds were whitefish and 102,600 pounds were trout. The value of the yield was $10,530. These figures include the catch of the set-lines used by the steamer fishermen, which amounted to 10,000 pounds of trout, valued at $500. All of the fish were sold fresh, principally in Chicago, about one-fourth being disposed of locally.

Set-lines.—In May, as soon as the days are long enough to admit of tending both gill-nets and set-lines, the latter are occasionally set while the steamers are running out to haul their nets. The lines have from four hundred to six hundred hooks placed 6 feet apart which are baited with ciscoes that have been caught by the mouth in the gill-nets. Trout averaging 10 pounds in weight are the only fish taken. No lines are set after the middle of July.

Haul-seines—Three of these were fished at Kenosha during the months of March and April, 1885. They were from 80 to 100 fathoms long, and were valued at $60 each. The catch, which consisted chiefly of suckers, was partly shipped to Chicago and the remainder sold locally. The value of the fish was only about $100.

Fyke-nets and trammel-nets.—The catch of six small fyke-nets which are set in Kenosha harbor in the early spring is made up of perch and bullheads, which are eaten by the fishermen and their families. Only about 1,500 pounds were taken in 1885, valued at $48.

One trammel-net is set along the outer beach in spring for suckers, and the fishermen go out in a boat, one rowing and the other frightening the fish into the net by striking the bottom. The catch is insignificant.

History of the pound-net fishery.—In 1862 a fisherman began to use pound-nets at Kenosha; but he left the vicinity about 1876. Another man afterwards engaged in this fishery for two years, and a third fisherman had five pounds in operation in 1880, but suspended business at the end of the year. The last pound-nets used in the locality were set in 1881. The species principally caught in the pound-nets was the perch. Whitefish and trout were seldom taken.

55. WAUKEGAN, LAKE COUNTY, ILLINOIS.

Geographical description.—Waukegan, the principal city of Lake County, Ill., is situated about 35 miles north of Chicago and 50 miles south of Milwaukee. Its inhabitants, numbering 6,000, are principally engaged in mercantile business in Chicago and in manufacturing.

History of the fisheries.—Waukegan is the only place between Chicago and Kenosha from which fishing is carried on. The early fishing was prosecuted with gill-nets, which have since gone entirely out of

use. Prior to 1855 there were but two gill-net fishermen in Waukegan. During that year five crews were organized, and in 1859 there were thirteen gangs. The next year, however, all but one of the crews had left, and the fishery was practically discontinued, although after the date named there was a little irregular fishing for two or three years. In 1884 a steamer with a gang of nets was used at Waukegan, but the crew were inexperienced men and caught nothing. With the decline of the gill-net fishery the pound-nets came into use, and although not very successful when first introduced (about 1867) have been continuously employed up to the present time, the fishery reaching its height between 1874 and 1878, when as many as 47 pounds were operated.

Gill-net fishery.—The first nets fished were from 330 to 400 feet in length, 4½ feet in depth, with a 4½-inch mesh; they cost $5 each, and were made in Chicago. Twenty nets constituted a gang, and eighty nets a full outfit for four men, this number of fishermen usually working together as partners, and keeping two gangs of nets in the water all the time. One gang was hauled daily, and the nets were taken ashore to be dried and mended, while another lot was put in their place. Buoys surmounted by flags 8 or 10 feet high were attached to the ends of each gang. Cedar floats 2½ feet long and 1 inch square were placed at intervals of 9 feet along the top line. A stone sinker weighing a pound was attached to the bottom of a net directly beneath each float.

Fishing began in the latter part of March or early in April, and continued till about the middle of November. The season of greatest yield was for two months in the spring, and again in August. Fishing was prosecuted three and one-half days in each week. The nets were set about 20 miles from shore in 35 fathoms of water, on a sticky blue clay bottom.

From one-fourth to one-third of the fish taken at that time were trout, and a large part of the remainder were whitefish. The trout were most plentiful in May and June, and again late in fall. The largest specimen caught in that early period weighed 63 pounds after the removal of the viscera; the average weight was 10 pounds dressed. Whitefish sometimes weighed as much as 15 pounds dressed, 3 pounds being the average. The daily catch did not vary much from 1,200 pounds of trout, whitefish, and minor species. The average stock in a season for four men was from $1,000 to $1,100.

About three-fourths of the catch was shipped fresh to Chicago, which at that time had but two firms in the fish trade. The price received was 3 cents a pound, dressed, delivered at the train in Waukegan. All the fish ranked as No. 1.

Pound-net fishery.—As already stated, this fishery was most extensive between 1874 and 1878. From the latter year there was a gradual decline, and in 1884 and 1885 only thirteen pound-nets were set. These were operated by the same number of men. The fishery deteriorated

chiefly because strong gales from the northeast injured or destroyed the nets, the waves frequently driving them upon the beach.

At first the pounds were set in March, but now the 1st of May is the opening of the season. They are left in until the middle or latter part of September, unless they are sooner injured by gales.

The nets in 1885 were set along the beach north of Waukegan for a distance of 7 miles in 18 to 26 feet of water, eight being arranged in pairs and five set singly. The leader is from 660 to 990 feet in length, and begins in water about 8 feet in depth; the mesh is 8 inches. The heart is made of netting with a 5-inch mesh, and approaches to within 10 feet of either side of the end of the leader. It is continued forward to form the tunnel, which extends into the pot a distance of 15 feet and has a 10-foot entrance and a 2-foot exit. The pot is located 30 feet beyond the end of the leader, is rectangular in shape, stretches 12 feet either side of the entrance of the tunnel, and has sides 30 feet long. When complete with stakes the nets cost $500 each. If patched they last three years.

The stakes used in the construction of the nets are from 28 to 35 feet long, 6 or 7 inches in diameter at the base, and 3 inches in diameter at the top. They are made of white or "bur" oak, and are cut by the fishermen in the woods near Waukegan. If cut when the sap is in the tree, the stakes last only from three to five years, but if cut in November they can be used for six or eight years. Each stake is worth $2. The stakes are driven into the bottom to the depth of 5 or 6 feet; it costs $25 to put down the stakes for each pound. The apparatus used for driving the stakes is 18 feet high, with uprights 10 inches apart, between which the hammer (weighing 110 pounds) plays. It is lashed upon two small boats which serve for its support when it is in operation.

The species taken in the pound-nets at Waukegan are whitefish, trout, sturgeon, herring, suckers, perch, and lawyers; none of them are abundant except the first named. In 1884 the total catch was 72,000 pounds, valued at $3,000. The yield in 1885 was less, the diminution being chiefly due to the influence of the winds, which have a marked effect on the abundance of fish in this section. If southerly winds prevail fishing is good, but if there is a continuance of northerly winds the fish move over to the Michigan shore, and are correspondingly scarce on the west side.

The catch in 1885 amounted to 44,900 pounds, of which 35,000 pounds were whitefish and 4,000 pounds trout. Seven thousand five hundred pounds of whitefish were smoked, yielding 5,000 pounds of the smoked article. All the other fish were sold fresh locally or shipped to Chicago. The value of the catch was $1,980.

Preparing the fish for market.—When the catch is landed it is taken to the fish-houses to be prepared for sale and shipment. The buildings are small frame structures, each provided with ice-chest, scales, bins, dressing table, washing trough, offal trough, etc. They often have a

shed along one side which serves as a store-house for barrels, nets, oars, salt, etc. The houses are located on the sandy beach within a few feet of the water's edge. When the boats arrive the fish are carried to the receiving troughs in front of the houses in barrows made of half-barrels with board handles. The troughs are inclined at a slight angle, and at the lower portion stands the cleaner, who culls the fish, scrapes their entrails into the waste tubs, plunges them into the wash trough, where the dirt and blood are removed, and then passes them into the house for icing and shipment. The fish lose about one-twelfth of their weight in dressing.

Attached to or near by the fish-houses are ice-houses made of rough boards, double-walled and lined with sawdust. Their size varies from 14 to 30 feet in length, 16 to 20 feet in width, and 10 to 15 feet in height. They are often sunk 6 feet below the surface.

Smoking of whitefish.—Some of the fishermen have little smoke-houses where the smaller fish are lightly smoked for local sale or shipment. These are mere huts, the largest being scarcely more than 7 feet square. Smoking began in a primitive way in 1869, increasing in a few years till 2,000 or 2,500 boxes, containing 10 pounds each, were smoked annually. For four years prior to 1885 only a few fish had been shipped, but 300 or 400 pounds were smoked weekly for home use.

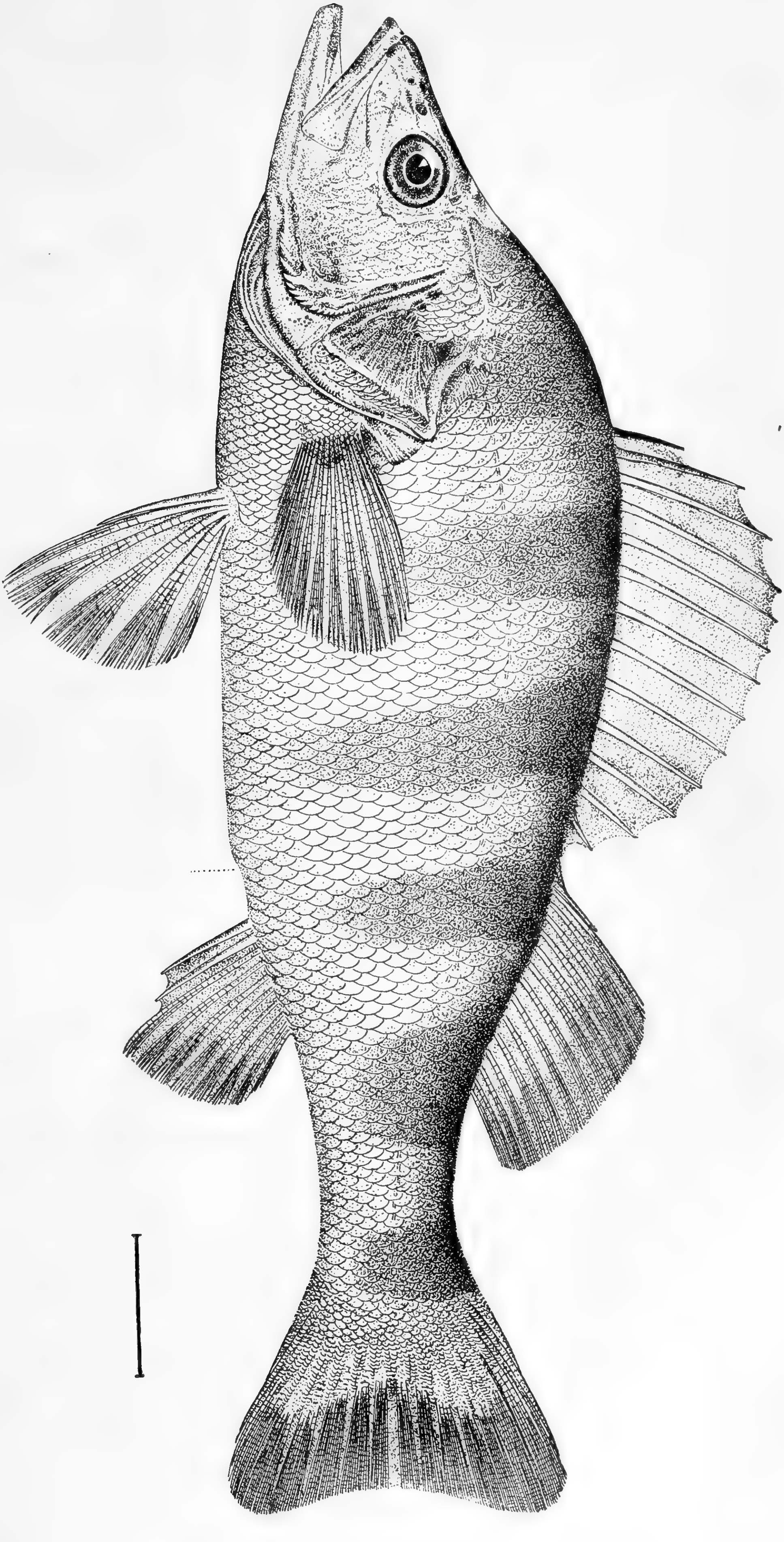
The smoking process is as follows: The fish are cleaned and put in brine for three to five hours; they are then impaled in strings of five on wooden sticks or iron bars, and hung in the smoke-house for about an hour to drain. A hard-wood fire is then started and for about half an hour they are smoked with the door of the house open, to fix them. The door is then closed and the fish are exposed to the smoke of a hot fire for three or four hours longer to give them a good color. The fish lose one-third of their weight in smoking.

About 5,000 pounds of No. 2 and No. 3 whitefish, herring, and small trout were thus prepared in 1885, bringing 7 cents a pound wholesale.

Capital invested in the fisheries.—This amounted to $8,365, divided as follows: Thirteen pound-nets, $6,500; 5 pound-net and 11 other boats, $525; shore property, $1,340.

56. CHICAGO AND SOUTH CHICAGO, COOK COUNTY, ILLINOIS.

Relative importance as fishing centers.—The coast-line of Cook County south of Chicago stretches for a distance of 10 miles to the Indiana State line; it is low and sandy throughout its whole extent. Chicago and South Chicago are the only places in the county from which fishing is carried on. Although Chicago is the center of a large fish trade, the commercial fishing in the immediate vicinity of the city is not at all extensive, and the city depends on more distant waters for its supply of fish. South Chicago, on the contrary, a town of 2,000 people at the mouth of Calumet River, about 12 miles from Chicago, is a fishing center of some importance; it is a manufacturing and railroad town, and



YELLOW PERCH (*Perca americana*).

something of a summer resort, one of its attractions being the good fishing afforded on the piers.

Non-professional fishing.—Pleasure fishing in both these places is followed by a great many people, and a large proportion of all the fish taken at Chicago is caught by persons not dependent on the fisheries for a livelihood; hand-lines and dip-nets are used, most of the fishing being done from the harbor piers and wharves. The dip-nets are either round or square, 8 or 10 feet in diameter; some are suspended from beams extending out over the water from the piers, being raised and lowered by means of a pulley at one end of the beam and a reel at the other. Not a few men are more or less dependent on this fishery for a living. Large, marketable fish are thus taken in paying quantities, but the chief use of the dip-nets is to provide minnows to serve as bait in pleasure fishing with hand-lines. Perch and eels are the species thus caught, the latter being taken in rather limited numbers. There is a little pleasure fishing from boats, the minnows in this case usually being caught by the fishermen themselves in small hand dip nets.

Species.—Perch is by far the most abundant species occurring in this section, it being taken in nearly double the quantity of all the other fish together, as will appear from the summary given elsewhere. Herring and whitefish rank next, and sturgeon and eels are common. There are no trout, bass, or pickerel obtained in this part of the lake.

Apparatus and methods of fishing.—Perch are taken at all seasons of the year when there is no ice, with dip-nets and hand-lines, as already described, and also with gill-nets, set-lines, and pound-nets. The gill-nets used for perch are about 150 feet in length, 4 feet deep, with a 1½-inch mesh. They are set off the northern end of the city of Chicago, and off the section between Twenty-seventh and Thirty-ninth streets in the southern part. The gill-net grounds for the fishermen of South Chicago are 8 or 10 miles south of that place.

The season for whitefish and herring is about the same as that for perch; that is, it begins early in the spring and continues until the formation of ice in the fall. They are caught in gill-nets and pound-nets similar in size and construction to those employed in other portions of the lake. Whitefish are thought not to spawn in this end of the lake.

Sturgeon are taken in pound-nets and on set-lines. The latter are used mostly in the winter by sailors and dock men, who are otherwise employed in the summer.

Trade.—All the fish taken at South Chicago are sent by wagons or by rail to Chicago in a fresh state, where they are disposed of to retail and wholesale dealers. The latter have apparatus for artificially freezing the fish, a considerable proportion of which are frozen for preservation and shipment. From estimates furnished by competent authority the following statistical statement has been prepared, showing in detail the extent of the wholesale fish trade of Chicago. The table gives the quantities of fresh and frozen lake fish handled by Chicago dealers in

1885, together with the quantities obtained from the British Provinces, and the amounts paid to the fishermen and received from purchasers by the wholesale dealers.

Species.	Total quantity handled.	Quantity artificially frozen.	Quantity of frozen fish received from Manitoba and other British possessions.	Amount paid by dealers to fishermen.	Amount received by dealers.
	Pounds.	*Pounds.*	*Pounds.*		
Whitefish	2, 171, 342	325, 701	19, 540	$97, 711	$130, 281
Trout	3, 414, 146	682, 829		136, 566	187, 778
Sturgeon	266, 000	26, 000		7, 980	10, 640
Herring	1, 124, 000	562, 000		22, 480	33, 720
Pike and pickerel	1, 050, 600	245, 120	35, 000	35, 018	49, 024
Bass, crappies, sunfish, etc	97, 200			2, 916	3, 888
Perch	151, 000	60, 400		3, 020	4, 530
Catfish and bull-heads	90, 600	5, 000		2, 718	4, 530
Lawyers, suckers, etc	50, 900			764	1, 118
Total	8, 415, 788	1, 907, 050	54, 540	309, 173	425, 509

In 1879 the total quantity of fresh fish handled in Chicago was 5,910,570 pounds. The figures in the above table, therefore, would indicate an increase of 2,505,218 pounds in six years. The extent of the salt-fish trade of Chicago in 1885 is shown in the following statement:

Kinds of fish.	Number of half-barrels.
No. 1 whitefish	45, 000
No. 2 whitefish	22, 500
No. 3 whitefish	5, 500
Trout and siscowet	30, 000
Pike and pickerel	2, 000
Suckers, bayfish, etc	4, 250
Herring and ciscoes	35, 000
All other lake fish	7, 000
Total	151, 250
Total pounds	15, 125, 000

The prevailing wholesale prices of fresh fish in Chicago in 1885 were as follows:

Kinds of fish.	Paid to fishermen.	Received by dealers.
	Cents.	*Cents.*
Whitefish	4½	6
Trout	4	5½
Sturgeon	3	4
Herring	2	3
Pike and pickerel	3½	5
Bass, crappies, sunfish, etc	3	4
Perch	2	3
Catfish and bull-heads	3	5
Lawyers, suckers, etc	1½	2

Statistics.—In 1885 there were in this section 30 professional and 363 semi-professional fishermen, and 60 shoresmen and preparators, upon

whom about 720 persons were dependent. They used 2 fishing steamers valued at $16,000; 42 boats valued at $2,695; 480 whitefish gill-nets, 132,000 feet in length, 62 herring and perch gill-nets, 8,675 feet in length, the total value of gill-nets being $3,788; 10 pound-nets, valued at $4,600; 234,000 feet of set-lines, with 23,400 hooks, valued at $200; and miscellaneous apparatus and shore property, fixtures, fish cars, and working capital to the value of $310,185, giving as the total amount of capital invested in the fisheries $337,468.

The yield of the fisheries of this section in 1885 was somewhat smaller than in 1884, owing, it was believed, to protracted cold and stormy weather preceding the close of the fishing season. The quantities of the various species taken were:

	Pounds.
Whitefish	81,696
Herring	75,165
Sturgeon	101,362
Perch	575,025
Eels, catfish, and other fish	27,927

The manufactured and secondary products consisted of 230 pounds of caviare, 80 pounds of isinglass, and 80 gallons of sturgeon oil; these were all prepared by one man, in South Chicago. The value of the fishery products was $72,041.

57. INDIANA.

General remarks.—The coast-line of Indiana, about 40 miles in length, is less in extent than that of any other state bordering on the Great Lakes, and the fisheries are of small importance. Indiana borders on the extreme southern part of Lake Michigan, and its shores are sandy and hilly throughout. There are but two places in the state from which fishing is carried on, and only one of these engages in fishing to any considerable extent. This is Michigan City, near the eastern state-line, in Laporte County, a railroad, manufacturing, and lumber town of 7,800 inhabitants. At one time fishing was one of the most important occupations of the people, but since 1879 there has been a gradual decline in the business, owing to the decrease of whitefish and sturgeon; perch, however, have been steadily increasing in abundance. One crew of pound-net fishermen, it may be said, were taking as many fish as ever in 1885, and believed the decrease is only apparent, the stormy weather preventing fishermen from going out into the lake after the fish.

From City West, an unimportant community in Porter County about 10 miles west of Michigan City, and the only other fishing center in the State, a little seine and set-line fishing is done in the spring and fall by two or three men from Chesterton, an inland town; six pound-nets, fished by as many men, are also set off the place, and are operated by two firms, one of which belongs at Toledo, Ohio, and uses the same nets at Monroe, Mich., on Lake Erie.

Pound-net fishery.—The pound-net fishery is the most important one at Michigan City. In it are engaged thirty-four men with twenty-six nets, divided among seven firms. Gill-nets and set-lines are also fished by the pound men. The pound-nets are set in water from 20 to 60 feet in depth, have leaders from 1,000 to 1,300 feet long, the mesh of the leaders being from 6 to 8 inches, that of the bowl from 3 to 4 inches; they cost from $200 to $800 each.

Other fisheries.—Gill-nets are used for whitefish, trout, herring, and perch throughout the year when there is no ice. Set-lines are fished in the fall, chiefly for sturgeon and perch.

Fishing grounds.—Pound-nets are set east and west of Michigan City to a distance of 5 or 6 miles. The gill-net fishermen set their nets from 2 to 20 miles from the shore. Owing to the fact that the fish do not come so close into shore as formerly, the fine seining grounds in this vicinity have been abandoned for a number of years. This has also necessitated the use of longer leaders in the pound-net fishery.

Disposition of catch.—Nearly all the fish landed in this section are shipped by the fishermen to market in a fresh condition. The few that are salted are intended for home consumption. About three-fourths of the yield go to Chicago, and about one-fourth to the inland towns of Indiana.

Statistics.—There were in this section, in 1885, 41 professional and 24 semi-professional fishermen, and 1 preparator, upon whom about 175 persons were dependent. The fishing apparatus and property consisted of 4 fishing-steamers, valued at $8,500; 41 boats, valued at $3,105; 799 whitefish, trout, herring, and perch gill-nets, 259,950 feet long, valued at $4,817; 29 pound-nets, valued at $17,600; 3 seines, 1,980 feet long, valued at $210; 250,000 feet of set-lines, with 30,000 hooks, valued at $317; and miscellaneous apparatus, shore property, and working capital, valued at $13,975; the total capital invested in the fisheries was $48,524.

The yield of the fisheries comprised 175,161 pounds of sturgeon, 5,500 pounds of herring, 134,890 pounds of whitefish, 34,215 pounds of trout, 93,740 pounds of perch, 4,330 pounds of suckers, and 560 pounds of eels. To these figures should be added the following quantities of salt and smoked fish: Sturgeon, 1,700 pounds smoked; herring, 2,000 pounds salted; and whitefish, 2,000 pounds salted, of which 1,300 were No. 1, and 700 pounds No. 2. The total value of these products was $17,673.

Secondary products.—The secondary and manufactured products were 8,600 pounds of caviare and 780 gallons of oil, valued at $1,172.

The caviare was all made by one firm at Michigan City and sold for 10 cents a pound. One man buys refuse fish of all kinds and makes oil therefrom; the scrap is not utilized. The market for the oil is Chicago, where 40 cents a gallon was obtained for it in 1885.

58. BERRIEN AND VAN BUREN COUNTIES, MICHIGAN.

Location of the fisheries.—There are three fishing communities in this section, New Buffalo and St. Joseph, in Berrien County, and South Haven, in Van Buren County. Of these places St. Joseph is by far the most important, both as regards the extent of its fisheries and in other respects. At one time the people of New Buffalo were more extensively engaged in fishing than in 1885, when it had only six fishermen and its 700 inhabitants were chiefly railroad men and merchants. It is situated near the southern county line, and the shore on either side is sandy and broken by hills. St. Joseph, a town of about 3,500 people, is nearer the northern county line, at the mouth of the St. Joseph River. It has a good harbor, two lines of steamers plying daily between it and Chicago; is a lumber center of importance; and has a large fishery interest. About two-thirds of the people are of German descent. South Haven is at the mouth of the South Black River. Its people, numbering about 1,900, are chiefly engaged in farming, lumbering, and mercantile pursuits. Over a hundred men were at one time employed in the fisheries at this place; in 1885 there were only thirty-six fishermen, and of these but fifteen were professional.

Fisheries of New Buffalo.—In 1879 the fish taken at New Buffalo amounted to 75,000 pounds; in 1885 the catch was but a little more than one-tenth as much, viz., 7,800 pounds. The apparatus consisted of one pound-net, fifty whitefish gill-nets, and set-lines with three thousand three hundred hooks, together with some minor apparatus. The only fish caught are perch, whitefish, and sturgeon; the first named constituting more than two-thirds of the total yield. The value of the products in 1885 was $290.

The fishermen of St. Joseph.—Nine-tenths of the fishermen of St. Joseph are Germans. They have at times met with serious disasters and, in addition to losing much valuable apparatus by storms, twenty-seven fishermen have lost their lives during the past twenty-five years. The men employed in the fisheries in 1885 numbered seventy-three professionals and sixteen semi-professionals, with five shoresmen and preparators. The greater part of these are hired by the firms operating the different fisheries, and receive from $1.50 to $2.50 per day, $2 being the average daily wages.

Pound-net fishery of St. Joseph.—The pound-net fishery carried on from St. Joseph is important and increasing yearly. The number of nets operated in 1885 was thirty-two, this being an increase of eleven nets over 1884. The nets are fished chiefly in the spring and fall, and take small whitefish and trout, sturgeon and herring. They are also set in the summer when there are runs of fish close in shore. The pound-net grounds are from 1 to 12 miles north and south of the town. The inner ends of the leaders are from 1,000 to upwards of 7,000 feet distant from the shore. The average gross stock of the pound-nets in 1885 was $390.

Gill-net fishery of St. Joseph.—Gill-nets are extensively operated at St. Joseph at all seasons when the lake is free from ice. In 1885 they numbered 2,750, having a total length of 626,130 feet, and were valued at $13,439. They are provided with wooden floats and leaden weights. Large whitefish and trout are taken in them. No nets are used for sturgeon or herring.

Seven fishing steamers, used both in the pound and gill-net fisheries, belonged at St. Joseph in 1885. They were valued at $27,000. Their crews numbered from three to seven, five being the average. They varied in size from 5 to 20 tons, net.

Past and present yield of St. Joseph fisheries.—While the catch of individual fishermen may have been less than in previous years, the actual yield of the fisheries in 1885 was considerably in excess of that for 1879. In the latter year the total catch of the St. Joseph fishermen amounted, in round numbers, to 500,000 pounds, of which about one-third were trout. In 1885 the total quantity of fish taken was 678,835 pounds, divided as follows among the different species:

	Pounds.
Trout	242,143
Sturgeon	171,630
Whitefish	159,862
Perch	62,700
Herring	25,500
Suckers	12,000
Bull-heads and catfish	5,000

The value of these products was $25,493.82. Of the trout, 500 pounds, and of the whitefish, 4,800 pounds, were salted.

Secondary products of St. Joseph fisheries.—Two men at St. Joseph are engaged in trying out oil from refuse fish obtained around the docks. They made 1,700 gallons in 1885 which sold in Chicago at from 25 to 35 cents a gallon. One man manufactured 16,625 pounds caviare in 1885; this was shipped to Europe. The sturgeon roe was bought of the fishermen at 5 cents a pound, who disposed of 14,500 pounds of roe and 3,825 sturgeon sounds. The value of these secondary products was $3,256.

The fisheries of South Haven.—The fishing at South Haven is chiefly for sturgeon, which appear to be partial to the local waters and can be taken whenever the lake is sufficiently free from ice to use set-lines. It is probable that spawning-grounds for this species occur not very distant from South Haven. Whitefish are not scarce, but are not much sought for; they are taken in gill-nets, of which there were four hundred and ten in 1885. Two pound-nets belonging to a Toledo fisherman were set off the shore, a few miles below South Haven, during a portion of the year. A little seining was done, with three small seines, at the mouth of the river. The fishery is unimportant, perch being chiefly taken. One South Haven steamer used set-lines and gill-nets for sturgeon. She had forty nets, which were the only ones used for

sturgeon in this section. Whitefish and trout gill-nets were also set by this vessel. Two other steamers from Chicago fished for sturgeon with set-lines during the winter of 1884–'85, making South Haven their headquarters.

Products of South Haven fisheries.—The yield of the fisheries of South Haven consisted of 51,760 pounds of sturgeon, 20,030 pounds of whitefish, 13,400 pounds of trout, 4,000 pounds of perch, and 600 pounds of eels; the whole being valued at $4,310.50. The secondary products were valued at $741, and included 6,500 pounds of caviare, 1,400 pounds of sturgeon roe, and 420 sounds. All the fish not consumed locally were sent to Chicago by steamer.

Statistical recapitulation.—The statistics of the three towns which have been referred to are as follows: The total number of men employed was 136, of whom 90 were professional and 41 semi-professional fishermen, and 5 shoresmen and preparators. The apparatus and other fishing property used comprised 10 steamers; 10 gill-net boats; 45 other boats; 3,210 whitefish and trout gill-nets, 762,130 feet in length; 40 sturgeon gill-nets, 12,000 feet in length; 35 pound-nets; 3 seines, 1,686 feet in length; 1 fyke-net; 1,033,000 feet of set lines, with 102,800 hooks; and other miscellaneous and minor apparatus.

The amount invested in steamers and boats was $43,592; in gill nets, $15,989; in pound-nets, $14,150; in seines, fyke, and set-lines, $1,378; in other apparatus, $3,520; in wharves, buildings, and other shore property, $11,600; the total capital, including $4,250 in cash, being $94,479.

The total quantity of fish landed was 776,425 pounds, divided among the various species in the following proportions:

	Pounds.
Trout	255,543
Sturgeon	223,690
Whitefish	181,892
Perch	72,200
Herring	25,500
Suckers	12,000
Bull-heads and catfish	5,000
Eels	600

All the above fish were sold fresh, except 4,800 pounds of whitefish and 500 pounds of trout, which were salted. The selling price of the fish was $31,101, to which should be added $2,989, the amount accruing from the sale of the following secondary products: 23,125 pounds of caviare, 15,900 pounds of eggs, 4,245 bladders, and 1,700 gallons of oil. This gives a total of $34,090 received for all kinds of fishery products.

59. ALLEGAN COUNTY, MICHIGAN.

Shore and population.—That portion of Allegan County bordering on Lake Michigan is 28 miles in length and is sandy throughout. The only fishing center of any importance is Saugatuck, situated on the Kalamazoo River about 3 miles from its mouth and three-fourths of a

mile overland from the lake. It has about 800 inhabitants, who are mostly Americans, engaged in farming, and, to some extent, in boat building. The fishermen are nearly all of German descent, and live together at "fish town," at the mouth of the river, from which all the fishing is done.

Set-line fishery.—Although gill-nets and pound-nets are extensively employed, the set-line or trawl is the favorite apparatus here. To illustrate by figures the extent of the set-line fishery, it may be stated that the lines used in 1885 had an aggregate length of 1,787,500 feet, or 338 miles, while the hooks numbered 168,000. Minnows are used for bait. Sturgeon and trout are thus caught, the former in greater quantity, and very exceptionally whitefish are also secured. Each of the six steamers fishing at Saugatuck employed set-lines along with other apparatus.

This fishery is followed chiefly in the fall and winter. The sturgeon caught average about 30 pounds dressed, this being considerably smaller than the average weight ten or fifteen years ago.

Other fisheries.—Sturgeon are also caught in gill-nets (of which 165 were set in 1885) and in pound-nets.

Trout and whitefish are taken in gill-nets and pound-nets (1,082 gill-nets and 11 pound-nets being employed); the latter species is the most abundant one at Saugatuck. Good spawning grounds for whitefish and trout occur on "Honey Comb" Reef, about 1½ miles southwest of the mouth of the river, in from 3 to 12 fathoms of water.

The other fish occurring in this section are not taken in sufficient numbers to be of any importance, with the exception of perch, as will appear from the statistical summary. They are bass, pike, catfish, and suckers.

Fishermen and lay.—The number of fishermen at Saugatuck in 1885 was fifty-seven, of whom twenty-six were professionals. When hired, the fishermen receive from $25 to $30 a month and board, or $2 a day. The firms prefer to hire by the day, but when they do so have to run the risk of not being able to secure the men's services when wanted. In many cases the shore fishermen and steamer's crews join forces with this understanding: the former furnish bait and apparatus, and the latter set and haul the gear, bring the fish to port, and take two-thirds of the catch as the steamer's share.

Statistics.—More than $30,000 were invested in the fisheries of this region in 1885, as follows: 6 fishing steamers, worth $15,000; 7 gill-net boats and 25 other boats, worth $1,810; 165 sturgeon gill-nets, 36,313 feet long, 1,082 whitefish and trout gill-nets, 238,726 feet long, 10 other gill-nets, 1,800 feet long, worth $5,638; 11 pound-nets, worth $2,700; 1,787,500 feet of set-lines, with 168,000 hooks, worth $1,135; 1 seine, 1,320 feet in length, worth $100; 2 fyke-nets, worth $20; other apparatus, worth $1,700; wharves, buildings, etc., worth $2,165; and working capital to the amount of $600.

The yield, valued at $16,845, was as follows:

	Pounds.
Whitefish	201,075
Sturgeon	139,224
Trout	43,425
Perch	14,325
Suckers	1,750
Pike	1,000
Bass	300
Catfish	274

Trade.—With the exception of 1,100 pounds of whitefish, which were salted, all the above were sold fresh. The local demand was not great, and the bulk of the products was sent to Chicago.

Two firms incidentally bought sturgeon roe and bladders, preparing therefrom 9,875 pounds of caviare and 125 pounds of isinglass. Two hundred gallons of oil were also extracted from refuse fish. The value of the raw products to the fishermen was $318.

Fisheries of Ganges.—At Ganges, a very small village south of Saugatuck, seven men engage in fishing at times, but are not dependent on the water for a living. Their apparatus and catch have been included with those of the fishermen at Saugatuck. They used one pound-net, one seine, and a few gill-nets and set-lines, taking, in 1885, 24,113 pounds of fish, valued at $898.91. Whitefish and sturgeon formed almost their entire catch.

60. GRAND HAVEN, OTTAWA COUNTY, MICHIGAN.

Character of the town and its fisheries.—Grand Haven is a town of 6,000 people, on Grand River, about 1 mile from its mouth. Lumbering is the principal occupation of the inhabitants, a large proportion of of whom are Dutch. Four steamers belonged at Grand Haven in 1885, and from them the principal fishing was carried on. Only three sail-boats were used.

Gill-nets are extensively employed both for whitefish, trout, and sturgeon, 1,921 being fished in the year covered by this report. Prior to 1885, gill-nets were almost the only apparatus used, but in that year a number of fishermen set pound-nets. These were fished throughout the season without much success, due, it is thought, to the unfamiliarity of the fishermen with this form of apparatus. Two nets were used in 1884 and thirteen the next season. In 1885 the average stock was $340—only a few dollars more than the average cost of the nets.

Indian fishermen.—At the "fish town" opposite Grand Haven is a small party of Indians who fish little themselves but clean the catch of the steamers, taking their pay in fish. They also make oil from the refuse, and buy a few fresh fish to smoke for their winter's use. Spearing and hand-lining is followed by Indians on Grand River, but they seldom fish in the lake.

Fishermen of Grand Haven and Holland.—In 1885 fifty-two men were engaged in fishing at Grand Haven, nearly all of whom were Dutch.

There were four other men at Holland, in the southern part of the county, who fished at times during the year and who should be added to the number given above. The fishing they do is unimportant, however, owing to the absence of any local demand for fish and the distance of markets. About one hundred and twenty-five persons are dependent on the fishermen of this county.

Statistics of apparatus and products.—The apparatus used in 1885 was as follows:

4 fishing steamers	$11,200
3 gill-net boats	385
24 other boats	645
115 sturgeon gill-nets, 25,800 feet long	396
1,806 whitefish and trout gill-nets, 372,650 feet long	8,826
13 pound-nets	4,070
1 fyke-net	10
320,000 feet of of set-lines, 32,000 hooks	159
Accessories	665
Wharves, buildings, etc.	1,015
Cash capital	700
Total value	28,071

The total yield of the fisheries of Grand Haven was 421,929 pounds, consisting of 166,196 pounds of herring, 102,405 pounds of trout, 87,245 pounds of whitefish, 52,868 pounds of sturgeon, and 13,215 pounds of perch, pike, and suckers. The value of the catch was $16,401.64. The catch at Holland was 13,750 pounds of perch, sturgeon, and whitefish, of which more than three-fourths were perch. The value was $240.

The secondary products were valued at $1,267, and consisted of 7,500 pounds of caviare, 1,100 gallons of oil (made by Indians), and 150 pounds of isinglass.

61. MUSKEGON AND MONTAGUE, MUSKEGON COUNTY, MICHIGAN.

Recent origin of Muskegon fisheries.—The fisheries of Muskegon are of comparatively recent origin. No mention is made of them in the Geographical Review of the Fisheries of the Great Lakes in 1879,* and it may be assumed that they have sprung into existence on a commercial scale since that time.

Character of the town.—Muskegon is a town of 18,000 people, near the head of Muskegon Lake, about 5 miles from Lake Michigan. The shores on either side of the mouth of the lake are made up of sandy hills and bluffs. The people, many of whom are foreign-born, are chiefly engaged in lumbering; and about fifty saw-mills are maintained on Muskegon Lake.

Fishing grounds.—The fishing is prosecuted from Port Sherman, at the mouth of the lake. This place is simply the headquarters of the

* The Fisheries and Fishery Industries of the United States. 4°, 1887. Section II, Geographical Review of the Fisheries.

fishermen, while the fishing grounds for pound-nets and seines extend north and south along the shore for 5 miles or more, the gill-net grounds being about $1\frac{1}{2}$ miles from shore in from 10 to 12 fathoms of water.

Effect of sawdust on fishing grounds.—The fishermen appear to be considerably hampered in their operations by the presence of great quantities of driftwood and sawdust from the mills. At times this débris covers the lake for miles around and very seriously interferes with seining and netting. The most disastrous effects, however, are seen on the fish themselves, especially during the spawning season. Spawning grounds formerly existed in this vicinity, but they have been deserted for some years, owing to the deposits of sawdust thereon.

Apparatus used at Muskegon.—Gill-nets for sturgeon, whitefish, trout, and herring are in common use at Muskegon, but are being superseded by pound-nets, of which eleven were operated in 1885—an increase of six over the previous year. There is a little seine fishing carried on, but, as previouly stated, this is interfered with by the driftwood from the mills. Set-lines are used rather extensively. Two steamers fished gill-nets and set-lines from here in 1885, taking their catch fresh to the Chicago market.

Statistics of Muskegon fisheries.—There were 46 fishermen in this place in 1885; of these 28 were professionals. About 96 persons were dependent on the fishermen.

The following is a detailed statement of the apparatus and capital invested in the fisheries of Muskegon:

2 fishing steamers	$5,000
7 gill-net boats	400
23 other boats	1,097
444 sturgeon gill-nets, 106,490 feet long	2,086
369 whitefish and trout gill-nets, 78,300 feet long	715
81 herring gill-nets, 19,250 feet long	405
11 pound-nets	3,250
1 trap-net	100
11 fyke-nets	112
5 seines, 1,756 feet long	270
557,000 feet of set-lines, 62,500 hooks	405
Accessories	780
Wharves, buildings, etc	500
Total value of apparatus	15,120

The catch was valued at $10,456. It consisted of 94,054 pounds of sturgeon, 39,252 pounds of herring, 31,252 pounds of whitefish, 43,790 pounds of perch, 17,000 pounds of catfish and bull-heads, 14,032 pounds of trout, and 8,000 pounds of suckers. These were all sold fresh, mostly in Chicago.

The secondary products derived from the fish were 4,300 pounds of caviare, 100 pounds of isinglass, and 60 gallons of oil, the total value of which was $576.

Montague and its fishermen.—The fisheries of Montague are very similar to those of Muskegon. The town itself is on a small lake some distance from Lake Michigan, and the fishermen make their headquarters at the mouth of White Lake, where there is a good harbor. Montague has 2,500 inhabitants, who are largely interested in lumbering, while the fisheries, although increasing, are as yet of minor importance.

The fishermen, of whom there were thirty-five in 1885, are Americans, Germans, Danes, Irish, and Norwegians, the first predominating.

Pound-net fishing from Montague.—Pound-nets were principally used in 1885, twenty-eight of them being set. Each gang has its own locality, and occupies about the same grounds from year to year. Pounds are usually set by May 1 and remain in the water till October or the 1st of November. The water in which the poles are driven is shallow, with sand or clay bottom.

Apparatus and capital in Montague fisheries.—There were employed in the fisheries of Montague in 1885 3 fishing steamers, worth $6,500, and 8 gill-net and 39 pound-net and other boats, with a combined value of $1,347. The apparatus of capture consisted of 395 gill-nets, with a length of 158,965 feet, valued at $2,341; 2 seines, 562 feet long, $50; 28 pound-nets, $5,075; 2 fyke-nets, $20, and 268,000 feet of set-lines, with 27,700 hooks, $250. The wharves and buildings had a value of $660, and the fixtures and accessories a value of $637. The total amount of capital invested in the fisheries was $16,880.

Products.—Sturgeon is the most profitable species taken here. It is caught with set-lines and in pound-nets, only one gill-net being employed in 1885. The average weight of the dressed sturgeon was about 33 pounds. The catch in 1885 amounted to 98,798 pounds, of which 3,000 pounds were smoked. The fish were worth about 5 cents a pound in 1885. The foregoing quantity yielded 3,800 pounds of roe, which sold at from 3½ to 4 cents a pound, and 850 swim-bladders, worth 5 cents each.

Neither whitefish nor trout were abundant, but both were of large size, averaging 5 or 6 pounds each. They were taken in gill-nets and pound-nets, 24,153 pounds of the former and 17,474 pounds of the latter being landed in 1885. Three hundred pounds of trout were smoked.

Herring are not abundant, only 16,460 pounds being caught. Of this quantity 500 pounds were smoked. They are taken only in pound-nets, no gill-nets for herring being used in this place.

The other kinds of fish occurring in this section are perch and pike, of which 4,667 pounds and 1,975 pounds, respectively, were caught.

The total value of the products was $6,596.

Secondary products.—One firm from Sandusky, Ohio, made caviare, isinglass, and oil at Montague, and 1,425 pounds of caviare, 150 pounds of isinglass, and 315 gallons of oil were manufactured. These prepared products sold for $460.

62. OCEANA COUNTY, MICHIGAN.

The fishing stations.—Clay Banks, Benona, and Pentwater are the only communities in Oceana County from which fishing is carried on, and the fisheries of Pentwater are the only ones that have any considerable commercial importance. Clay Banks and Benona are small villages of about 100 people each, situated north of Montague. The inhabitants are chiefly farmers, and but four men in the former and two men in the latter are engaged in fishing.

Fisheries of Clay Banks.—At Clay Banks the apparatus consisted of three pound-nets, and the catch, amounting to 38,300 pounds and valued at $1,500, was made up as follows:

	Fresh.	Salted.
	Pounds.	*Pounds.*
Sturgeon	15,000	200
Whitefish	13,200	1,700
Trout	5,000	500
Pike	1,000	200
Perch	1,500	....

Fisheries of Benona.—The fishermen of Benona operated 2 pound-nets and 105 whitefish and trout gill-nets. Their catch was 4,180 pounds of sturgeon, 6,800 pounds of whitefish, and 2,760 pounds of trout; and sold for $568.

The fisheries of Pentwater.—Pentwater is a town of 1,500 people, on a small harbor in the northern part of Oceana County. The shore on either side is made up of clay, and sand banks. Lumbering is the principal occupation of the people. The fisheries have increased since 1879, when there were but four men engaged in fishing and the yield was only 7,000 pounds. In 1885 there were twenty-two professional and two semi-professional fishermen, and the catch was twenty-five times that of 1879, as will appear from the context.

Apparatus and methods of Pentwater fisheries.—Pound-nets are more extensively used at Pentwater than any other form of apparatus. Seven gangs of fishermen, consisting of twenty-two men, operated twenty-one pound-nets; the same men fished one hundred and twenty-nine whitefish and trout gill-nets, two seines, and 58,000 feet of set-lines. But the pound-net fishery consumed most of their time, and the other apparatus was used incidentally rather than regularly. The men have shanties on the side of the harbor opposite the town, and remain there during the fishing season. About half the pound-nets are set double, but in no case are more than two set together. The leaders of the pounds are about 1,300 feet in length with 8-inch mesh; the mesh of the bowls is 3 or 4 inches. The pounds are set as soon as the ice moves out, and are left in the water until November. As in portions of the lake farther south, the fishermen here are troubled by the presence of quantities of sawdust and drift-wood from the saw-mills. There

was one steamer at Pentwater used in connection with the fisheries; she carried four men, and tended pound-nets exclusively.

Products of the fisheries of Pentwater.—The yield of the fisheries of Pentwater amounted to 174,268 pounds, and included 67,591 pounds of sturgeon, 60,500 pounds of whitefish, 20,775 pounds of trout, 11,652 pounds of perch, 5,800 pounds of pike, 4,000 pounds of suckers, and 3,950 pounds of herring, the entire catch being valued at $7,789. To this sum should be added $190, the value of 9,000 pounds of sturgeon roe and 1,005 sounds. The manufactured products were 6,300 pounds of caviare, which sold for $630, and 75 pounds of isinglass, valued at $98.

Market.—Chicago is the market for the fish, which are packed in ice in fish-cars and shipped by steamer. Fish-cars are not used below this place on the eastern shore of Lake Michigan; twenty-nine were employed in 1885.

Statistics.—A complete statistical summary for the entire county follows:

Men: Twenty-eight professional fishermen, 2 semi-professional fishermen. Persons dependent, about 60.

Apparatus: One fishing steamer, $1,400; 4 gill-net boats and 21 other boats, $2,645; 254 whitefish and trout gill-nets, 50,800 feet in length, $948; 26 pound-nets, $7,415; 2 seines, 1,615 feet in length, $160; 80,000 feet of set-lines, 8,500 hooks, $95; 29 fish-cars, $375; other apparatus and accessories, $500; wharves, buildings, etc., $1,110; cash capital, $150. Total capital invested in the fisheries, $14,798.

Products: Fresh fish: Sturgeon, 86,771 pounds; whitefish, 80,500 pounds; trout, 28,535 pounds; perch, 13,152 pounds; pike, 7,000 pounds; suckers, 4,000 pounds; herring, 3,950 pounds; total, 223,708 pounds. Salt fish: Sturgeon, 200 pounds; whitefish, 1,700 pounds; trout, 500 pounds; pike, 200 pounds; total, 2,600 pounds. Secondary products: 9,000 pounds of sturgeon eggs, 1,005 sturgeon sounds. Manufactured products: Caviare, 6,300 pounds; isinglass, 75 pounds. Value of salt and fresh fish, $9,857; secondary products, $190; manufactured products, $728.

63. MASON AND MANISTEE COUNTIES, MICHIGAN.

Fishing centers.—The fisheries of this section are centered in Ludington, Mason County, and in Manistee and Portage Lake, Manistee County.

Ludington and its fishermen.—Ludington is a lumbering town of 4,000 inhabitants, many of whom are foreigners. It is situated on Pere Marquette Lake, about a mile from the shore of Lake Michigan. The fishing settlement is at the mouth of the harbor. There were twenty-six fishermen in 1885, most of them being Norwegians.

Gill-net fishery of Ludington.—Whitefish and trout gill-nets are more extensively used than any other form of apparatus, five hundred and ninety having been fished in 1885. Owing to the fact that the fish keep far

offshore the fishermen are obliged to start for the grounds early in the morning, and it is frequently late at night before they return with their fares. It is believed that the large quantities of sawdust in the water near the shore have caused the fish to frequent the deeper water in the center of the lake instead of coming nearer the land as formerly. The average stock of individual gill-nets in 1885 was between $9 and $10.

There was one fishing steamer employed from Ludington in 1885. This carried five men, and fished one hundred gill-nets, running out about 18 miles from shore and setting the nets in 80 fathoms of water. This vessel also tended two pound-nets, located north of Ludington, during the months of June and July. The catch of the gill-nets by months and by kinds of fish is shown in the following table:

Species.	Apr.	May.	June.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Blackfins	5,610	9,840	8,330	5,435	5,460	17,445	6,460	4,000	62,580
Whitefish	380	2,440			300				3,120
Trout	725	1,670		125			370	375	3,265
Total	6,715	13,950	8,330	5,560	5,760	17,445	6,830	4,375	68,965

Relative abundance of common whitefish and blackfins.—In certain localities on Lake Michigan it has generally been found difficult, and in some instances impossible, to show separately in statistical form the catch of whitefish (*Coregonus clupeiformis*) and blackfins (*Coregonus nigripinnis*). These fish have therefore been combined under the name of whitefish. The foregoing table is consequently useful, since it shows the proportion of whitefish proper to the black-finned variety, and the great preponderance of the latter over the former in this portion of the lake at least.

Pound-net fishery of Ludington.—The six pound-nets operated from Ludington have not been a profitable investment, for their owners have failed to get a livelihood from them. This will be evident when it is stated that the nets averaged $200 in cost; that it requires more men to manipulate them than are needed for gill-nets; that the great body of fish is miles distant from the coast; these constituting a combination of conditions that resulted in 1885 in reducing the average net stock (exclusive of expenses) to $45 or $50.

Statistics of Ludington fisheries.—The amount of capital invested in the fisheries of Ludington was $6,910, divided as follows:

1 fishing steamer	$1,500
8 gill-net boats	405
4 other boats	170
590 whitefish and trout gill-nets, 143,900 feet long	2,760
6 pound-nets	1,300
1 seine, 660 feet long	50
4 fyke-nets	40
10 fish-cars	75
Other apparatus	115
Wharves and building	395
Working capital	100

The yield of the fisheries amounted to 135,904 pounds, including 96,145 pounds of whitefish, 31,084 pounds of trout, 4,500 pounds of herring, 2,075 pounds of sturgeon, and 100 pounds of pike; also 2,000 poounds of salt whitefish. The value of the catch was $5,864. No caviare, isinglass, or oil was made in this section in 1885. The fishermen ship their own fish, most of which go to Chicago by steamer.

The town of Manistee.—The town of Manistee is situated between Lake Michigan and Manistee Lake, in the southern part of Manistee County. It has a population of about 11,000, who are chiefly engaged in lumbering.

Past and present importance of Manistee fisheries.—The fishery interests of the place appear to be on the decline, although as compared with 1879 there was an actual increase in 1885 as regards the number of persons employed, the amount of capital invested, and the total quantity of fish taken. The increase in the first two respects, however, was more than commensurate with the augmentation of the catch.

Pound-net fishing prevented by sawdust and drift-wood.—Owing to the great amount of saw-dust, logs, and drift-wood occurring in the waters of the lake in the vicinity of Manistee, it has been found impracticable to carry on the pound-net fishery, which otherwise would be a profitable one. The obstructions mentioned have wrecked and torn the nets to such an extent that more money was required to keep them in repair than could be obtained for their catch even were there no such drawbacks.

Gill-net fishery of Manistee.—Gill-nets are the apparatus in most general use, six hundred and fifty-eight being fished in 1885. These are somewhat interferred with by logs and drift-wood, but being set far from shore and below the surface of the lake, they do not suffer so materially from drift stuff as pound-nets would. The average earnings of gill-nets was only $4 or $5, although the more fortunate or energetic fisherman had a considerably larger stock. One steamer fished from Manistee during a portion of 1885, but was at Frankfort from June 20 until November 1; it carried a crew of five men, and fished 300 gill-nets.

Statistics of the apparatus and capital in Manistee fisheries.—Four seines, 1,400 feet long and valued at $320, fishing at the mouth of the Manistee River stocked about $200 on whitefish. Set-lines of the length of 59,200 feet, with 7,600 hooks, worth $70, fished in the fall and winter months for perch, complete the list of apparatus. The accessory apparatus included a fishing steamer already referred to, valued at $2,000; 6 gill-net boats, valued at $315; 3 other boats, valued at $35; miscellaneous apparatus worth $100, and wharves and buildings valued at $2,465. The total capital invested in the fisheries was $10,361.

Products of Manistee fisheries.—Whitefish and trout are caught in gill-nets, and limited quantities of the former species of small size are also taken in haul-seines. The catch in 1885 was valued at $3,370, and consisted of 45,300 pounds of fresh whitefish, 3,900 pounds of salt whitefish, 22,875 pounds of trout, and 6,100 pounds of perch. No other kinds were taken.

Importance of Portage Lake fisheries.—Portage Lake is 6 miles north of Manistee. It is 3 miles long and a mile wide. Onekama is the only place of any size on its shores. A few fishermen live there, but the great body of them are at Williamsport, where the lake empties into Lake Michigan; here there are fifty-two people—all fishermen or dependent on the fisheries. The fisheries carried on from Portage Lake are more important than those at either Ludington or Manistee, although at the former place there are more men employed and at the latter more capital invested.

Apparatus and methods of Portage Lake fisheries.—One steamer at Portage Lake fished 250 gill-nets, one pound-net, and several set-lines in 1885, taking $1,000 worth of whitefish, trout, and perch.

There were also 505 other gill-nets and one other pound-net operated by the fishermen in addition to a small amount of set-lines. The pound-nets were not very profitable, yielding only about $240 each.

The gill-net fishing grounds are about 15 miles from the shore. On certain reefs, about 4 miles from Portage Lake, there are trout spawning beds. This fact probably accounts for the greater abundance of trout at this point than at either Ludington or Manistee. The whitefish taken here averaged from 1½ to 2 pounds; they were about as abundant as at Ludington and Manistee.

Statistics of Portage Lake fisheries.—Fourteen professional and 5 semi-professional fishermen were employed at Portage Lake in 1885, on whom 33 persons were dependent. They possessed apparatus worth $8,569. It consisted of 1 fishing steamer, 8 gill-net boats, 4 other boats, 755 whitefish and trout gill-nets, 247,100 feet in length; 2 pound-nets, and 32,500 feet of set-lines with 4,500 hooks.

The yield was 171,818 pounds of fresh fish and 24,460 pounds of salt fish valued at $7,959. The catch was made up of 95,520 pounds of whitefish, 68,098 pounds of trout, 7,000 pounds of sturgeon, 1,000 pounds of perch, and 200 pounds of pike; the salt fish consisted of 22,760 pounds of trout, 1,000 pounds of sturgeon, and 700 pounds of whitefish.

Disposition of products.—The fish are first sent to Manistee in a small steamer, whence they go to Chicago. The salt fish are for home consumption chiefly.

Statistical recapitulation.—The following is a complete recapitulation of the fisheries of Ludington, Manistee, and Portage Lake, the tables representing, respectively, men, apparatus, capital, and products:

Table of persons employed in the fisheries of Mason and Manistee Counties in 1885.

	Professional fishermen.	Semi-professional fishermen.	Shoresmen and preparators.	Persons dependent.
Ludington	15	9	2	57
Manistee	15	2	1	34
Portage Lake	14	5	....	33
Total	44	16	3	124

Table of apparatus and capital employed in the fisheries of Mason and Manistee Counties in 1885.

	Fishing steamers.	Gill-net boats.	Other boats.	White-fish gill-nets.	Length of gill-nets.	Pound-nets.	Fyke-nets.	Seines.	Length of seines.	Length of set-lines.	Hooks.
					Feet.				*Feet.*	*Feet.*	
Ludington	1	8	4	590	143, 900	6	4	1	660	....	....
Manistee	1	6	3	658	168, 400	....	....	4	1, 400	59, 200	7, 600
Portage Lake	1	8	4	755	247, 100	2	....	....	....	32, 500	4, 500
Total	3	22	11	2, 003	559, 400	8	4	5	2, 060	91, 700	12, 100

	Value of foregoing apparatus.	Value of accessories.	Value of wharves and buildings.	Amount of cash capital.	Total.
Ludington	$6, 225	$190	$395	$100	$6, 910
Manistee	7, 796	100	2, 465	....	10, 361
Portage Lake	8, 234	150	185	....	8, 569
Total	22, 255	440	3, 045	100	25, 840

Table of products of the fisheries of Mason and Manistee Counties in 1885.

	Fresh fish.						Salt fish.			Total catch.	Value.
	White-fish.	Trout.	Stur-geon.	Perch.	Her-ring.	Pike.	Trout.	White-fish.	Stur-geon.		
	Lbs.	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	*Lbs.*	
Ludington	96, 145	31, 084	2, 075	....	4, 500	100	....	2, 000	....	135, 904	$5, 864
Manistee	45, 300	22, 875	....	6, 100	....	....	....	3, 900	....	78, 175	3, 370
Portage Lake	95, 520	68, 098	7, 000	1, 000	....	200	22, 760	700	1, 000	196, 278	7, 959
Total	236, 965	123, 057	9, 075	7, 100	4, 500	300	22, 760	6, 600	1, 000	410, 357	17, 193

64. FRANKFORT AND SOUTH FRANKFORT, BENZIE COUNTY, MICHIGAN.

Frankfort Harbor.—The villages of Frankfort and South Frankfort are separated from each other by a small body of water known as Frankfort Harbor or Becs Scies Lake. This lake, about one-eighth of a mile wide, serves as an excellent harbor for vessels and boats, the only entrance being by an artificial channel cut through a neck of sand about 20 or 30 rods wide, with breakwaters and a light-house at the outer extremity. The shore on either side for a distance of 6 to 10 miles is a succession of low sand-hills, the nearest openings being Herring River, 6 miles south, and Platte River, about 10 miles north of the village.

History of the fisheries.—Frankfort proper has about 1,500 inhabitants, and South Frankfort from 400 to 500. The fisheries were formerly of little importance, but for the past few years fishing steamers and sail-boats from the fishing towns farther south (chiefly St. Joseph) have been coming to Frankfort at certain seasons of the year, when fishing was dull in other localities, to engage in common with the fisher-

men of Frankfort in the capture of whitefish and trout with gill-nets. Fish in this vicinity are more or less abundant at all seasons, and the small steamers that run daily to Manistee and another line of boats direct to Chicago afford facilities for shipping fresh fish to market. The first of the St. Joseph steamers came in 1883, and the next year there were five of them fishing for a greater or less period from the harbor, with one or two additional sail-boats.

Fishermen.—The fishermen are chiefly foreign-born—natives of northern Europe. Sometimes a number of them own a fishing rig in common, although a majority of the rigs are owned by the captain of the crew, who hires his fishermen at from $30 to $50 per month.

The fishing season.—Owing to the early breaking up of the ice along this portion of the coast, the gill-net fishing often begins as soon as the first or middle of March and continues without interruption till late in December. The pound-net season, however, is of short duration, beginning about the middle or last of June and ending the latter part of September.

Species.—The yield of the gill-nets is about two-thirds whitefish and one-third trout for the steamers, though perhaps the percentage of trout for the small boats fishing nearer shore would be somewhat larger. The pound-net catch averages about 90 per cent. white fish, with about 7 or 8 per cent. trout and 2 or 3 per cent. sturgeon, in addition to the suckers and other fish which are thrown away, amounting to about 20 tons in 1885.

Statistics.—In 1885 there were two St. Joseph steamers fishing in Frankfort throughout the entire season, with one other from the same place fishing here for about one month, and one from Manistee fishing from the 20th of June to the 1st of November engaging in the fisheries of her home port both before and after fishing at Frankfort. The last two steamers will be included in the fisheries of their respective ports, but the first two having fished at Frankfort throughout the entire season should be credited to that place. These, with eleven sail-boats employing a total of 44 men, constitute the gill-net fleet, there being in addition seven pound-nets valued at $2,800, furnishing employment to 10 additional fishermen, three others from the gill-net fleet giving a portion of their time to the pound fisheries. The total amount of capital invested in the fishery industries, including the boats, nets, and shore and other property, amounted to $41,750. The catch reached 885,504 pounds of whitefish and 344,942 pounds of trout, the whole valued at $51,585. Of the whitefish, 504 packages of No. 1, 599 of No. 2, and 111 of No. 3 were salted, in addition to 424 packages of trout, the remainder of the catch being sold fresh.[1]

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[1] The word packages as used here or elsewhere is synonymous with half-barrels and barrels. The favorite fish package of the lake region is a half-barrel generally holding 100 pounds. This is, however, called a barrel or simply a package as frequently as by its definitive name, and the vernacular of the trade has been adopted here.

Trade.—The catch of all the steamers with the exception of the soft and waste fish is sent in ice to Chicago. The fish caught by one of the sail-boats is shipped fresh to Milwaukee while the remainder are sold to a local dealer who ships them to Chicago and other places. The pound-net fish are mostly salted. The price received from the Chicago dealers averages 4½ to 5½ cents for whitefish and trout, which are weighed and shipped without sorting.

Gill-net fishery.—The steamers carry an average of four hundred to four hundred and fifty nets each, fishing chiefly north of Frankfort village off Glen Haven and about the Manitou Islands, occasionally going to the Fox Islands, fully 60 miles distant. The sail-boats, numbering eleven in 1885, carry from fifty to two hundred nets each and fish only a few miles from the mouth of the harbor. The fishing begins early in March or at latest by the 1st of April, and continues uninterruptedly till December when the rough weather prevents the sail-boats from venturing out, and two or three weeks later the steamers are obliged to haul up. The whitefish are abundant at all seasons, constituting nearly two-thirds of the entire catch, though during the six weeks beginning with October 1 trout are taken in somewhat greater quantities. About 5 per cent. of the whitefish taken in gill-nets are of the varieties called blackfins and long-jaws, which occur in the proportion of about three of the former to one of the latter. The nets used average about 50 fathoms in length. They are almost exclusively cork and lead, only one small rig of float and stone being used in 1885. The boats differ greatly. Among them may be seen the mackinaws, hurons, Norwegians, and several mongrel types. Some are well built and expensive while others are small and of little value. The average for the entire fleet would be about $115.

Pound-net fishery.—The first pound-net in the vicinity of Frankfort was set in 1875, since which time three or four nets have been fished with greater or less regularity. In 1884 three pounds were fished between Platte and Herring Rivers, and the following season seven were in use, this being a greater number than heretofore employed in any one year. The catch averages from 200 to 250 half-barrels of salt whitefish to the the net, in addition to a quantity of fish too small for salting, which are thrown away. The nets are set late in June, and most of them are taken out by the middle or last of September.

Seine fishery.—Seine fishing has never been important. In 1885 one seine was used at Platte River for some six weeks, the catch amounting to about 200 half-barrels of salted fish. Another seine, owned at South Frankfort, was not fished at all during the year.

Other fisheries.—There is no winter fishing of importance with either hooks, nets, or spears, for the reason that the limited amount of ice on the lake does not favor it. No fykes are owned in the locality and but two trammel-nets were in use, these having been brought here by St. Joseph fishermen, and occasionally set in winter in the river and inland

lakes for pickerel and other species. No set-lines or herring-nets are used.

Secondary products.—About 100 barrels of oil are made annually by a man who utilizes all of the offal from the gill-net fishermen. These are prevented from trying out the oil themselves by the residents of Frankfort, who object to the odor which arises, and the man who carries on the work is obliged to conduct operations at quite a distance from the settlement.

65. ARAL TO GOOD HARBOR, LEELANAW COUNTY, MICHIGAN.

General observations.—For more than twenty years this region has had a scattered population, consisting principally of Scandinavians, Germans, Bohemians, and Poles. There are no villages near the shore, the post-office hamlets of Aral, Empire, Glen Haven, Glen Arbor, North Unity, and Good Harbor containing less than a dozen houses each.

The fisheries have been carried on to a limited extent since the first settlement, but have never been very important. The pound-net fishery is at present larger than ever before, while gill-net fishing, on the other hand, has declined. These two are the only kinds of apparatus which have ever been regularly fished, spears and lines being very rarely used even for home supply.

Pound-net fishery.—The first pound-net set on the mainland between Frankfort and Leland was located near Glen Arbor in Sleeping Bear Bay in 1863, and two years later seven pound-nets were set in Good Harbor Bay. In 1885 there were five pound-nets in Sleeping Bear Bay. The nets are usually put into these waters some time in May or June, and taken out about the middle or end of September, when the apparatus is removed to Traverse Bay, where it is kept in till the ice forms. The size of mesh varies from 2½ to 5 inches in the leaders, 3 to 4 inches in the hearts, and 2½ to 4¼ in the pots, which are about 30 feet square, and from 30 to 36 feet deep. The leaders are from 412 feet to 742 feet long, averaging about 544 feet. In no instance are several nets set in a string, one beyond the other. Sometimes a net is made out of the remains of several old ones. Two or three of the boats used in the pound-net fishing are sail-boats and the rest are small skiffs. Usually the nets are fished by the owner, who hires his assistants at $30 a month. Occasionally they are run on shares, half of the gross catch falling to the owner.

Gill-net fishery.—Gill-net fishing has been carried on to a limited extent for many years, reaching its height about the year 1879 or 1880. The nets ordinarily used are from 35 to 45 fathoms long and 14 to 16 meshes deep, with a mesh 4¼ to 4½ inches. The number carried averages twenty-two nets to the boat. In 1885 there was one gill-net crew at Empire, one at Glen Haven, two at Glen Arbor, and two at a place

called Port Oneida, near North Unity, half of the number fishing only in a small way in connection with their farming and other business. This is a considerable decrease over the year 1884.

Statistics.—In 1885 there were 19 professional and 6 semi-professional fishermen, fishing 14 pound-nets, worth $2,300, and 110 gill-nets worth $350, the value of buildings and accessories amounting to $1,455. The catch in 1884 was 131,800 pounds whitefish, 1,210 pounds trout, 1,000 pounds of herring, and 200 pounds of sturgeon worth $4,154, of which only 13,300 pounds of whitefish, 110 pounds of trout, and 200 pounds of sturgeon, having a value of $680, were sold fresh. The salt fish is shipped to Chicago and Milwaukee, chiefly the former. A greater part of the fresh fish is sold locally, there being only one exception, in which case all were sent, in 1884, and a portion of them in 1885, to Chicago. Of the salt whitefish 463 packages were No. 1, 385 packages No. 2, 237 packages No. 3, and 100 packages No. 4, each package containing 100 pounds of fish.

66. GRAND TRAVERSE BAY AND VICINITY (ANTRIM, GRAND TRAVERSE, AND PART OF LEELANAW COUNTIES), MICHIGAN.

Physical characteristics.—Grand Traverse Bay is the largest indentation on the eastern side of Lake Michigan, and next to Green Bay the largest in the entire lake. It is inclosed by the counties of Leelanaw on the west, and Charlevoix, Antrim, and Grand Traverse on the east, the last-named county also forming the southern boundary. Its greatest length from north to south is 35 miles, and its average width 10 miles. From its southern end a narrow peninsula, 18 miles in length, juts up from Grand Traverse County. The depth of the bay varies from 10 to 102 fathoms, the latter depth occurring in the southwestern part, opposite Elk Lake.

Fishing towns.—The principal communities on the bay from which fishing is carried on are Norwood, Elk Rapids, Old Mission, Traverse City, Bower's Harbor, Norrisville, Sutton's Bay, Omena, and Northport. On the shore southwest of the mouth of the bay are Gill's Pier and Leland.

Apparatus of capture.—The fisheries of this region are prosecuted chiefly with gill-nets and pound-nets, and to a less extent with spears, seines, and fyke-nets. Of these the gill-nets are the most numerous and important apparatus used, employing more men and yielding more products.

Species.—The species occurring in this region are trout, whitefish, blackfins, suckers, herring, perch, and, rarely, sturgeon. Trout are most plentiful in the fall, between about October 10 and November 10, during which time they are practically the only fish taken. After that date whitefish and the black-finned variety appear in about equal proportions, and are caught until the winter freeze, and again in the spring and summer. Blackfins spawn during the late fall and winter

months, and are found plentiful in 15 to 30 fathoms on mud and clay bottoms.

The whitefish taken in pounds in the spring average 2 pounds each, and the trout 6 pounds. In the fall the whitefish average $1\frac{3}{4}$ pounds, and the trout 8 to 10. Blackfins are taken weighing 4 pounds, but they average less.

Preparation of products.—About four-ninths of the total catch is salted; trout, whitefish, blackfins, and suckers, being the species so utilized. Twelve thousand pounds of trout and blackfins were smoked by two men at Traverse City and Northport and sold for 7 cents a pound. The canning of Whitefish and trout was begun at Northport in 1883. A practical canner was employed and many fish were put up that year. There was difficulty in disposing of the products, however, and in 1884 nothing was done. In the fall of that year the works passed into other hands and were devoted to fruit canning in 1885.

Trade.—The only market for fish in this region is at Traverse City, where four men were employed in 1885, who handled 159,500 pounds of fish, of which 110,000 pounds were whitefish, 28,000 pounds trout, 20,000 pounds blackfins, 1,000 pounds herring, and 500 pounds sturgeon. Four thousand pounds of blackfins and 1,000 pounds of trout were salted before shipment, and 4,000 pounds of whitefish were frozen. The amount invested in the business in 1885 was $5,300.

Statistical summary.—A total of 193 men were employed in the fisheries of this section in 1885, of whom 136 were professionals, 5 semi-professionals, and 6 shoresmen and preparators. The total capital invested was $29,924, of which $5,310 represented boats, $14,608 apparatus of capture, and $10,006 shore property, accessories, and cash capital.

The aggregate catch was 935,400 pounds, valued at $32,757. Of this amount 523,400 pounds, valued at $16,517, were sold fresh; 400,000 pounds, valued at $15,400, were salted; and 12,000 pounds, valued at $840, were smoked. The fresh fish included 272,000 pounds of whitefish, 223,400 pounds of trout, 9,000 pounds of herring, 4,000 pounds of sturgeon, and 5,000 pounds of mixed fish. The salt fish consisted of 192,000 pounds of whitefish, 178,000 pounds of trout, and 30,000 pounds of suckers. Equal quantities of trout and whitefish were smoked.

Gill-net fishery.—The nets employed average 240 feet in length and vary in depth from 14 to 25 meshes. The size of the mesh depends on the species taken, the blackfin net being $3\frac{1}{2}$ inches and the trout and whitefish 4 inches. Four-fifths of the nets are of the float-and-stone variety, costing $5.50 each, while only one-fifth are rigged with cork and lead, and cost $7 each.

Gill-nets are very extensively operated in Grand Traverse Bay and on the lake side of the peninsula north of Leland. The localities from which the principal fishing is done are Old Mission, Traverse City, Sutton's Bay and vicinity, Omena, Cat Head, Carrying Point, the light-

house on the jutting peninsula in the bay, Leland, and the shore north of Gill's Pier. The total number of nets used from those places was 2,011, with a total length of 542,900 feet. One hundred and forty-four men, of whom 118 were professionals, were required to fish them; of this number 10 were also engaged in pound-net or seine fishing. There were 26 semi-professionals, who were farmers and Indians and used from ten to forty nets each.

The regular gill-net crews contain two men each, who have one boat and from forty to sixty nets. The boats are mostly mackinaws worth from $40 to $175, $80 being the average price.

Fishing is carried on throughout the entire open season, but is generally discontinued after the formation of ice. Two crews, however, fished nets under the ice in 1885, catching 3,000 pounds of whitefish and trout valued at $120. Five crews at Sutton's Bay and Old Mission operate their nets only in the fall, using only ninety-five nets altogether.

The species caught are whitefish, blackfins, and trout, the yield of the last named being about equal to that of the two others combined. Each boat averaged $60 per month in 1885 from the sale of fish, the average stock of two men for a season being $300. One-third of the gill-net fish are salted, and the others are sold fresh to dealers at 4 cents a pound.

The total capital invested in this fishery was $19,733, of which $4,560 represented the value of 66 boats, $11,663 gill-nets, and $3,500 shore property and accessories.

The products of the gill-net fishery were 797,900 pounds, valued at $27,577. The salt fish amounted to $364,000 pounds and sold for $14,560. Of the total catch 135,000 pounds were whitefish, 238,000 pounds were blackfins, and 344,900 pounds were trout.

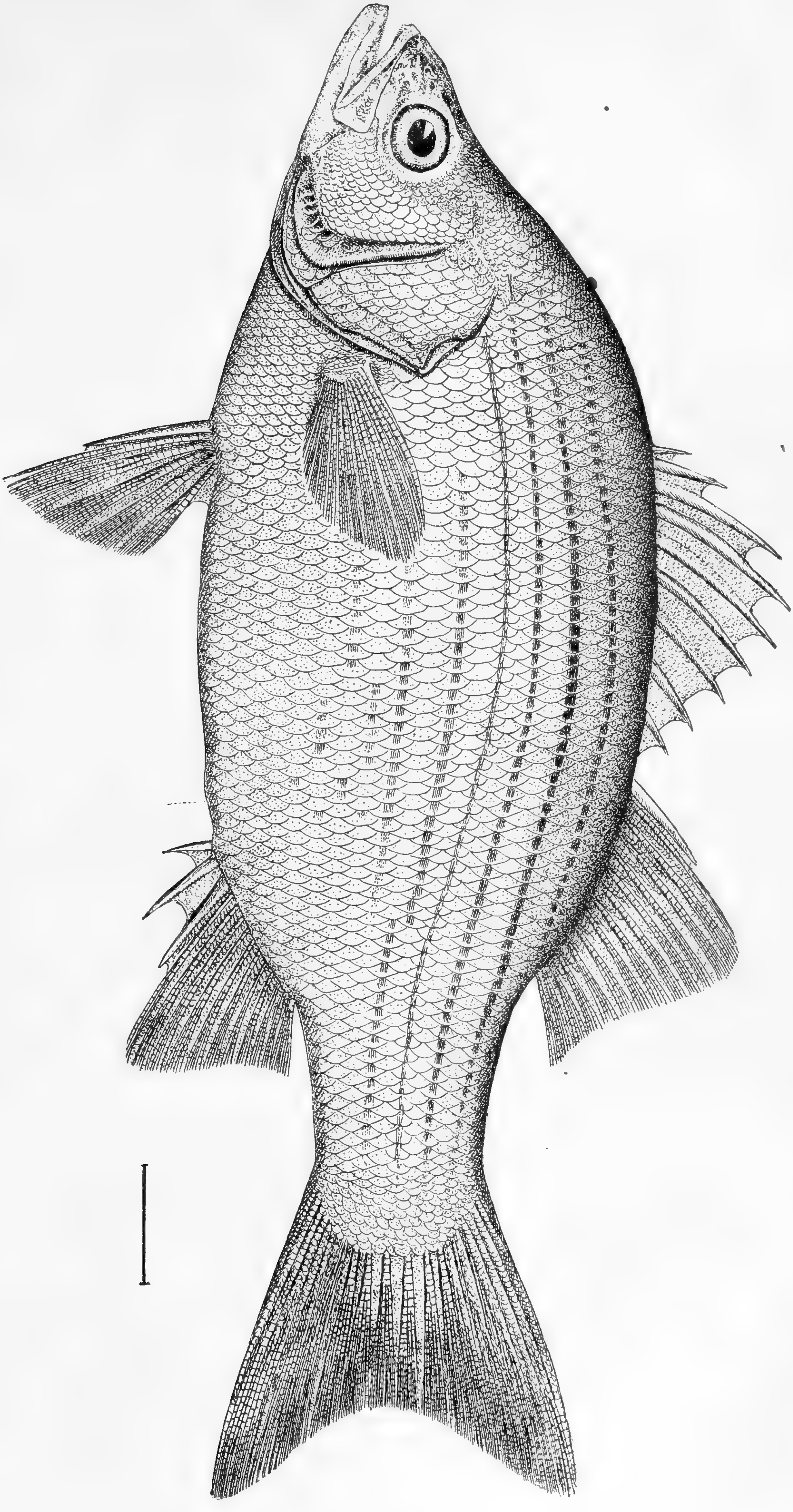
Pound-net fishery.—The first pound in the bay was set at Antrim City in 1867. This was successfully fished, but no others were introduced till 1869, when one was brought from Toledo. There were never more nets set than in 1885, when the number properly accredited to the bay was further augmented at times by nets temporarily brought from other places—Sleeping Bear Bay and the Fox Islands, for instance.

The location of nets in Grand Traverse Bay was as follows;

One off the north end of Torch Lake; one off Elk Lake, below Elk Rapids; three in the southern part of the eastern arm of the bay; one on the peninsula opposite Elk Rapids; three on Hog Island in Bower's Harbor; two below Sutton's Bay, and one at Northport.

The season of the pound-net fishing begins about the 1st of May and continues until the 1st of July, when the nets are laid up until October 15, from which date the fishing continues until the 1st of January. Early in the season two men constitute a pound-net gang; later, when trout are caught in large quantities, an increased force is required. When the nets are being put in, the crews lend mutual aid in driving the poles.

PLATE XXIV.



WHITE BASS (*Roccus chrysops*).

The pound-net fish are trout, whitefish, and herring, with a few sturgeon. In the spring, about four-fifths of the catch are whitefish, the remainder being one-fifth trout and four-fifths herring. In the fall, from October 15 to November 25, nine-tenths of the yield are trout and one-tenth whitefish; after November 25, about 95 per cent. are whitefish. Two-thirds of the total catch are taken in the fall.

The capital invested in this fishery in boats was $280; in nets, $2,500, and in shore property and accessories, $700. The output in 1885 was 64,000 pounds, of which 32,000 pounds were whitefish, 24,000 pounds trout, 4,000 pounds herring, and 4,000 pounds sturgeon. Four thousand pounds of the trout and 2,000 pounds of the whitefish were salted. The catch was valued at $2,310.

Spear fishing.—This is engaged in by sixteen men during the period of ice formation. The extent and value of the ice fisherman's outfit is about as follows:

Shed	$12.00
Sled	3.00
Stove	4.00
Spear	5.00
Dip-net	1.50
Ice-chisel, or "spud"	2.00
Decoy fish	1.00

The sheds are 4 feet wide, 6 feet long, and 6 feet high, made of 1½-inch lumber. They are provided with stoves and bunks, and are drawn to the fishing grounds on sleds. Holes are made in the ice with the "spud;" and these are kept clear of slush with the dip-net, and the decoy fish is lowered in the water. This done, the fisherman is ready for work. The spears used are 7 feet in length, the distal half being of iron into which a wooden handle fits. The spear has five prongs 8 inches long arranged in a line 7 inches in length. When the spear is launched at a fish, a line attached to the end enables its withdrawal from the water.

This fishery is fairly productive, the average catch to a man being 400 pounds of trout weekly during a fishing season of six weeks, and the total catch amounting to 38,500 pounds, valued at $1,550.

Other fisheries.—These consist only in a little fyke-netting and seining during a portion of the year. Five fykes, fished in the spring, were valued at $165 and caught 15,000 pounds of blackfins, herring, and perch in 1885. Two seines were fished on the shore between Gill's Pier and Northport, the fish caught being suckers, which were salted to the number of 300 packages, worth $600, in 1885.

67. CHARLEVOIX, CHARLEVOIX COUNTY, MICHIGAN.

Population of town.—Charlevoix is a town of about 1,500 people, situated at the western end of Pine Lake, a large body of water extending far inland from Lake Michigan. In 1858 but four families lived in the

place; it has grown steadily in importance and since 1877 has been frequented as a summer resort by Chicago and Kalamazoo people. There is now more fishing prosecuted from Charlevoix than ever before.

Pound-net and seine fishery.—The first pound-net was set here about 1862; in 1866 others were set; in 1879, however, there was but one; and in 1885 none were employed. The use of seines has also been discontinued since 1883, prior to which date they were employed in the capture of herring and other species. No fyke-nets, trammel-nets, or spears are used at this place.

Gill-net fishery.—The only fishery of importance is that with gill-nets for whitefish and trout. As early as 1866 three gangs of gill-net fishermen with seventy-five nets to a boat, began operations at Charlevoix. In 1885 there were 2,826 nets in the water, having a total length of 606,900 feet, the average length being about 35 fathoms. The nets have from 4 to 4½-inch mesh, are from 18 to 20 meshes deep, and cost about $6.50 each. The fishing season is from May 1 to December 15, between which dates the fishery is followed without intermission. Both steamers and boats are used in connection with this fishery at Charlevoix, four of the former and eleven of the latter being employed. The tugs carry five and six men, with from one hundred and fifty to four hundred gill-nets; the small boats carry two and three men, with from forty to two hundred and seventy-five nets.

The steamers have no regular fishing grounds, but set their nets wherever fish happen to be. In 1885 the localities most frequented were the Manitou Islands, Cross Village, and Old Mission. Three of the steamers, namely, *Seawing*, *Fisherman*, and *Clara E. Elliott*, fished at Sand Beach, Alpena, and Saugatuck, respectively, in the spring of 1885; the remaining one, the *Anspach*, was at Charlevoix during the entire season. The catch of the steamers while fishing from Charlevoix was as follows:

Steamers.	Whitefish.	Trout.
	Pounds.	*Pounds.*
Anspach	84,933	42,466
Seawing	50,891	38,520
Fisherman	49,372	41,254
Clara E. Elliott	11,959	9,341
Total	197,155	131,581

The following statement of the operations of the steamers *Seawing* and *Fisherman* gives the monthly fluctuations in their catch of whitefish and trout:

Month.	Whitefish.	Trout.	Total catch.
	Pounds.	*Pounds.*	*Pounds.*
June	25,041	19,815	44,856
July	25,956	19,332	45,288
August	30,149	18,547	48,696
September	19,117	22,080	41,197

Reference to the above summary shows that in August when the catch of whitefish was largest fewer trout were taken, and on the other hand that in September when the trout were most numerous the whitefish were least abundant.

The gill-net crews fishing from sail-boats take their fish on Seven-Mile Reef, and as far south as Fisher's Island and Norwood. Seven-Mile Reef is about 7 miles in length and 4 miles wide, and is covered by from 5½ to 20 fathoms of water; it is the ground most frequented by the boat fishermen.

Set-line fishery.—Set lines are fished by the steamer *Clara E. Elliott*, after the close of the gill-net season for steamers, which is earlier than for the boats. The season continues during the winter until April 15, being suspended only during the coldest weather. Fifteen thousand hooks in three gangs were used in 1885; the hooks are 6 feet apart and consequently 90,000 feet of ground-line were required. Sturgeon, trout, and whitefish are the species taken, one-half the catch being sturgeon and five-sixths of the remainder whitefish. Suckers and whitefish are used for bait. The lines are set on clay and sandy bottoms, in 7 fathoms of water in the fall, gradually increasing to 30 fathoms in the spring. The yield in 1884 was 10 tons; in 1885 but 5 tons were taken. The roes, swimming bladders, and refuse parts of the sturgeon were utilized in the manufacture of caviare, isinglass, and oil.

Trap fishery.—Four traps, costing $50 each, were set in Pine and Round lakes in the spring and fall by the gill-net fishermen. The catch was not large and consisted of trout, wall-eyed pike, and perch.

Ice fishing.—This is followed without much regularity at Charlevoix, owing to the fact that in only about one year in five does sufficient ice form. It is carried on chiefly by Indians, who use hooks and a few gill-nets. The total catch in 1885 was 10,000 pounds.

Species.—Trout is the most abundant species. The average weight of the fish caught in 1885 was 5 pounds. About one-fifth of the trout are of the local variety known as siscowet, although as many as one-half of the trout caught in deep water by some fishermen are of this variety. Whitefish rank next in abundance, and average 2½ pounds in weight. One-third are of the varieties called black-fins and long-jaws. Suckers are very numerous, but are not esteemed for food and are thrown away. Often when fishing on shallow grounds each steamer takes as many as a ton daily. Sturgeon, herring, perch, etc., are not taken in any great quantities.

Fishing season.—The best months for whitefish are May and June, when they constitute about half the catch, although in August the catch of the steamers consists of more whitefish than at other times, as already stated. Black-fins occur all the year round in deep water; they are taken in water from 30 to 60 fathoms in depth. In the fall the trout begin to outnumber the whitefish, and in October and November practically all the gill-net fish are trout.

Salted and smoked fish.—Only a small proportion of the catch is salted or smoked. In 1885, 151 packages of whitefish and 223 packages of trout were salted. The smoking of fish is of recent origin at Charlevoix; it began in 1883, trout being the only species used.

In 1884, 8 tons of fish were smoked, and in 1885, 12 tons, of which three-fourths were trout and one-fourth whitefish. Two men were then engaged in smoking fish at Charlevoix. The smoked fish are all disposed of locally at 10 cents a pound.

Wages.—The boat fishermen as a rule own the nets which they use. The men on the steamers, however, are mostly hired, and receive $30 each per month. The captains and engineers of the steamers are paid $50 a month. Packers of fish, net menders, and other shore hands receive $40.

Markets and prices.—The fish of this place go principally to Chicago, Detroit, and Petoskey. A Detroit firm has a branch house at Charlevoix, which handles a large proportion of the fish taken there. The secondary products of the fisheries—caviare, sounds, and oil—are sent chiefly to a dealer in Saugatuck. The prices received by the fishermen are 3 cents a pound for whitefish and trout, and 7 cents for sturgeon. Salt whitefish and trout are worth about $3 a package. Smoked fish are disposed of locally at 10 cents a pound. Sturgeon roes are sold at 3 cents a pound, sounds at 5 cents each, and oil at 30 cents a gallon; caviare brings 10 cents a pound and isinglass $1.25 a pound.

Statistical summary.—Forty-nine fishermen, of whom 37 were professional and 12 semi-professional, were at Charlevoix in 1885; there were also 8 shoresmen, preparators, and mechanics.

The four steamers fishing from this place were valued at $12,100, and the small boats at $1,265; the gill-nets were worth $18,369, and the other apparatus of capture $500; the shore property was valued at $3,000, and the cash capital amounted to $800; the total investment in the fisheries being $36,034.

The quantity of products taken in 1885 was much in excess of previous years and amounted to 733,850 pounds of fresh, salt, and smoked fish, of which about half were trout. Thirty-seven thousand four hundred pounds of trout and whitefish were salted, and 24,000 pounds of these species were smoked. The value of the catch was $21,819. The secondary products consisted of 700 pounds of caviare, 50 pounds of isinglass, and 375 gallons of oil, valued at $260.

68. LITTLE TRAVERSE BAY, EMMET COUNTY, MICHIGAN.

General observations.—The only villages on the shores of Little Traverse Bay are Harbor Springs and Petoskey, with populations of 2,000 and 3,000 respectively. The fisheries are of comparatively little importance, but a Petoskey firm handles large quantities of whitefish and trout, which are purchased from fishermen of the Fox and Manitou Islands, Grand Traverse Bay, and Charlevoix.

Gill-net fishery.—This is largely conducted by Indians, who have ten to fifteen nets each and fish along the shore. These are joined in the fall by farmers, who fish for about six weeks or two months when the trout are spawning. There are five crews along the north shore of the bay between Harbor Springs and Appleton, one at Harbor Springs and three along the south shore between Petoskey and Burgess. These crews number two men each, the average catch amounting to about 4,000 pounds to a boat. The boats are smaller than those farther north, and have an average value of only $50 each. Prior to 1883 a larger number of people were engaged in gill-netting; but a very severe storm in the fall of that year carried away a majority of the nets then in the water, and many fishermen have not been able to replace them. Until recently net-fishing through the ice has not been attempted, but in the winter of 1884-'85 parties from Harbor Springs fished regularly for eight weeks with fifteen nets and caught whitefish and trout of the value of $400.

Pound-net fishery.—Little Traverse Bay has the deepest pound-nets to be found along the eastern shore of Lake Michigan. The first one was set in the vicinity of Harbor Springs in 1879, but was not very successful. It was at first 103 feet deep, but it has since been cut down to 87 feet. Another of the same depth, a third of 85 feet, and two others each 80 feet deep have also been constructed. In 1884 seven nets were set here by residents of Harbor Springs and four additional by Petoskey fishermen. In 1885 thirteen nets were used, nine of them belonging to Harbor Springs fishermen. Six were set on the south shore in the vicinity of the hamlet of Carpenter, and the other seven near Harbor Springs on the north shore. The fishing season begins early in May and continues till the middle or last of November. The catch is three-fifths whitefish and the remainder trout. Ten per cent. of the whitefish taken at Harbor Springs were black-fins. Almost the entire catch is sold fresh to the Petoskey dealers or to the hotels at Petoskey and Harbor Springs.

Ice and other fishing.—From twenty to thirty huts are owned in the locality, and during the winter months these are moved about from place to place on the ice. Their owners, who are mostly Indians and half-breeds, do not fish with much regularity. Many of them spear only enough fish for their own use, while others get small quantities, which they sell to the residents of the villages. According to those best informed it is estimated that not more than 15,000 pounds were taken during the entire winter of 1884-'85, these being almost exclusively trout. No seines are at present fished in the locality, and set-lines are now seldom, if ever, used.

Preparation and trade.—One man at Harbor Springs buys and smokes a few small whitefish, caught in the pound-nets, supplying the local trade and shipping small lots to the interior of the State. This business is very limited, hardly exceeding a ton for the entire year. At Petoskey per-

haps three-fourths of a ton was smoked and consumed locally during the same period.

Harbor Springs and Petoskey each have a firm engaged in shipping large quantities of fish. One of these has a collecting steamer for buying fish from other localities, and has also a freezing-house, where the fall catch of whitefish and trout is stored until there is a demand for them at good prices.

For 1885 the bulk of the fresh fish was shipped to inland towns of Michigan, while the salt fish were sent to Chicago or consumed locally.

The fish trade of Petoskey in 1885, as indicated by the quantities of fish purchased at that place, amounted to 271,996 pounds, of which 152,656 pounds were whitefish and 117,740 pounds were trout, the remaining 1,600 pounds consisting of herring and minor species. About one-fifth of the whitefish and trout was frozen before shipping.

Recapitulation.—In 1885, if we include the fish merchants, 41 men, with 121 gill-nets and 13 pounds, were engaged in the fisheries. These had capital amounting to $25,610 invested in the fisheries, and caught 93,862 pounds of whitefish, 82,608 pounds of trout, and 30,715 pounds of other species, the whole valued at $8,495.

69. CROSS VILLAGE AND GOOD HART, EMMET COUNTY, MICHIGAN.

General description.—The stretch lying between Waugoshance Point and Good Hart, a distance of 25 or 30 miles, has a low, sandy shore, the woods extending almost to the water's edge. Cross Village, a town of seven hundred inhabitants, is the only settlement of importance, if we exclude Good Hart, a small Indian settlement of from twenty to thirty houses. Fish have been abundant from the earliest settlement of the region, and the Indians, who, with a few French Canadians, constitute nearly all of the population, were formerly almost wholly dependent upon the fisheries, though for a few years some of them have turned their attention to lumbering.

Pound-net fishery.—Pound-nets have been extensively fished here for twenty to twenty-five years, and very large catches have been made yearly till the present time. In November, 1866, one man took from two nets (each in 20 feet of water) set 1 mile south of the village, 1,663 packages of No. 1 whitefish in nine days, which he sold for a trifle over $13,000. The fish were so abundant that at no time was he obliged to lift the pound, but could simply dip out from the surface such quantities as he could care for. At the end of the ninth day the fishing was suddenly terminated by the bursting of the net. There were in 1884 nine pound-nets in the locality, from which over 3,000 half-barrels of fish were salted and 20 tons additional were sold fresh. In 1885 there were twelve pounds, and the catch was nearly as large as the previous year, though the fish averaged much smaller in size.

Gill-net fishery.—The gill-net fishery was formerly extensive, but there were at Cross Village in 1885 only one crew of white men and

two of Indians fishing regularly, and two other Indian crews fishing during a portion of the year. At Good Hart, 7 miles distant, where the fishing is wholly by Indians, twelve boats with twenty-four men followed the fisheries with considerable regularity. The Indian crews are usually provided with not more than ten or fifteen nets each. Their catch is small, averaging only about 50 packages to the boat, nine-tenths of which is salted. About three-fourths of the fish caught in the gill-nets are whitefish and the rest trout.

Ice fishing.—Fishing through the ice with nets and spears was formerly extensive, but it has decreased in importance until it is followed with very little regularity, though a good many of the Indians supply their own tables with fish in this way during the winter months, and a few get limited quantities for sale in the neighborhood.

Statistics.—In 1885 there were in the district lying between Waugoshance Point and Good Hart, inclusive, 46 fishermen, with 320 gill-nets and 12 pound-nets, and various accessory apparatus, boats, and shore property, the whole valued at $11,135. The products consisted of 152,000 pounds of whitefish, 36,000 pounds of trout, 10,000 pounds of herring, and 2,000 pounds of suckers, worth $7,625. Of the above fish 120,000 pounds of whitefish, 30,000 pounds of trout, and 10,000 pounds of herring, valued at $6,310, were salted. The salt fish are shipped direct to Milwaukee and Chicago or sold to dealers in the locality, while the greater part of the fresh fish are sold to dealers from Beaver Islands and Mackinaw City, though a few are consumed locally. Of the salt whitefish, 80,000 pounds were No. 1, 20,000 pounds No. 2, and 20,000 pounds No. 3.

70. MACKINAW CITY, CHEBOYGAN COUNTY, TO POINT WAUGOSHANCE, EMMET COUNTY, MICHIGAN.

General remarks.—Mackinaw City is situated at the extreme northern point of the southern peninsula of Michigan, on the Straits of Mackinac, which connect Lakes Michigan and Huron. It has a population of about 300 people.

The only other inhabitants of this section are about twenty-five families at Callam's Mill, and two pound-net fishermen living on Big Stone Bay.

Unimportance of the fisheries.—The fisheries have been carried on for at least ten years, but have never been important. Those at Mackinaw City are insignificant and consist entirely of trout-spearing through the ice, although certain pound-net fisheries in Lake Huron are operated by parties from this place.

Pound-net fishery.—In 1877, 3 pound-nets were set on the shore west of the "city," and the fishing was very good, 92 packages of whitefish being taken from two nets in a single day. In 1884 there were 5 pound-nets which were all set in Big Stone Bay, where 3 were still fished, but with small results, in 1885.

The leaders are placed, respectively, in 18, 30, and 40 feet of water. The pot is 24 feet square, and the mesh varies from 3½ inches in the lead to 2½ inches in the pot. The nets are fished in the spring from May 20 to July 25, and about September 10 they are returned to the water, where they remain till there is danger from the ice, which is usually about the 1st of December. No pound-net fishing had been carried on under the ice prior to 1885, but fishermen from Mackinaw City designed making a trial of this method in the winter of 1885–'86.

Gill-net fishery.—The gill-net fishing is of very small proportions, and in 1885 there were only two crews, one fishing in Cecil Bay and the other in Big Stone Bay. One crew were Canadians and the other crew half-breeds. Most of the nets used are about 165 feet long and 14 meshes deep, with a 5½-inch mesh, but several of the number are herring-nets of a 1½-inch mesh. The gill-net fishing is carried on from the breaking up of the ice in the spring until it forms again in the fall. No gill-nets are fished under the ice.

Seine fishery.—No seines were used previous to the spring of 1885, when one was fished for suckers near Callam's Mills by a crew of five men in the early part of May, during the first two weeks after the ice had disappeared. The seine was 165 feet long by 5 to 8 feet deep, with a 4-inch mesh. The total catch was 75 packages, which were sold at $1.75 a package.

Trout-spearing.—About a dozen men, mostly Indian half-breeds, but including several Americans, fish for trout with spears from the middle of January to April 15. The better class have a small shanty, with a hole in the bottom and a little stove in one corner. This they carry upon a sled to the fishing station, and cut a hole in the ice immediately under the central aperture. The spear, which has an iron head with from five to seven prongs, is secured by a long cord to the top of the shanty, so that when the fish is speared his escape is rendered almost impossible. Many of the spearmen do not go to the expense of providing themselves with a hut, but simply build a little fire upon the ice and use a blanket as a wind-break.

Other fisheries.—Hand-line fishing, or "snatching," as it is locally called, is practiced little, if any, at present, although the Indians have sometimes fished considerably in this way through the ice, using a "coop" or blanket for shelter, as the spearmen do. No trammel-nets or fykes have been used in the region. Several years ago a few set-lines were tried, but with no success, and in 1885 none were used.

Statistics.—In 1885 the total number of fishermen for this coast, including Mackinaw City, was 6 professional, 32 semi-professional, and 3 preparators. The capital invested amounted to $2,690, and the products were 39,000 pounds of fresh fish and 14,500 pounds of salt fish, having a value of $1,563.

Trade.—The entire catch was bought and shipped at Mackinaw City, where fish are purchased both from the fishermen of Lake Michigan

and from those of Lake Huron who fish in the vicinity of that place. In 1885, between May 1 and October 1, 120,000 pounds of fresh fish and 70,000 pounds of salt fish were handled, divided as follows among the different species:

Kinds.	Fresh.	Salt.
	Pounds.	*Pounds.*
Whitefish	60,000	49,000
Trout	42,000	7,000
Wall-eyed pike	12,000	....
Herring	....	7,000
Suckers	....	7,000
Sturgeon	6,000	....

The amounts paid to the fishermen were $4,200 for fresh fish and $2,398 for salt fish. Four men were employed as preparators, and $1,600 was invested in the business in wharves, buildings, fish-cars, etc.

71. BEAVER, FOX, AND MANITOU ISLANDS, MANITOU COUNTY, MICHIGAN.

General description.—The scattering islands in the northern end of Lake Michigan constitute the county of Manitou. There are, strictly speaking, three groups, the Beaver Islands, the Fox Islands, and the Manitou Islands. The distance between the most northern point of the first named group and the southern extremity of the last mentioned is nearly 70 miles. The islands have for many years been inhabited by fishermen, as fish were abundant in the vicinity, and the fishing grounds could be more readily reached from the islands than from the mainland. The total population is about 2,000, nearly all of whom are foreign born, and earn their livelihood by fishing or farming.

Beaver Island group.—The Beaver Islands are the most important and most numerous. They are situated about 40 miles west of Mackinaw City and 30 miles distant from Petoskey and Harbor Springs, and are made up of Beaver, Garden, High, Hog, Gull, Trout, and Squaw Islands. The county seat is at St. James, a village of 400 inhabitants, located on an excellent harbor near the northern extremity of Beaver Island, the largest of the group. About one-half of the people in the county reside on this island, where at least two-thirds of the adult males are engaged in fishing to a greater or less extent. Fishing is by far the most important industry, and most of the money in circulation is obtained from this source. Fully 90 per cent. of the entire population are Irish. The others are chiefly French, Germans, and Scandinavians, with an occasional American. High Island, 4 miles to the westward, is the home of twenty or thirty families of Indians, but only two white men live there during the winter months. Garden and Hog Islands come next in importance, but these have no harbors suitable for vessels, and only three or four families reside there permanently. The other islands are small and unimportant.

Fox Island group.—North Fox Island, about 8 or 10 miles southwest of the nearest headland of Beaver Island, and South Fox, 4 miles farther on, are of some importance from a fishery standpoint, and the latter has some good farms and a few permanent residents.

Manitou Island group.—North Manitou Island lies 18 miles southwest of South Fox Island. South Manitou is 5 miles farther to the southwest. The population of this group is about 700, of whom the majority are Germans, Danes, Swedes, and Norwegians, with very few Americans. The soil is suitable for farming, which, with a little fishing, is the principal industry of the people.

Fishing season.—The fishing begins on the islands as soon as the ice opens in April and continues until December, with the exception of September, when, owing to the scarcity of fish and the abundance of "moss" in the water, the nets are taken out and put in order for the fall fishing, which begins in October.

Apparatus, wages, etc.—The two forms of apparatus in most general use are gill-nets and pound-nets. The older fishermen generally own the apparatus, while the younger men are paid from $25 to $35 a month for assisting them. Many semi-professional fishermen, however, who farm during the greater part of the year, own and fish their own nets.

Shipments.—For many years no fresh fish were shipped, the entire catch being salted and sold to the dealers and to traders who visited the islands to barter with the fishermen. Since 1882 or 1883 a few tons of fresh fish have been shipped annually from the more northern islands by one of the larger firms, and in 1884 a collecting steamer from Manistique bought a few for shipment to Chicago. The business was small, however, and the total quantity of fresh fish sold that season did not exceed 20 tons. In 1885 the fishermen of the Manitou Islands began selling fresh fish to Petoskey. In the spring of 1885, a company was established on these islands, with steamers and pound-nets for catching fish, and sail-boats for buying additional quantities from the fishermen. The fish trade at the islands is extensive. During 1885 between one and two millions of pounds were shipped, these being mostly fresh trout, whitefish, sturgeon, and herring, with ten or twelve per cent. of salt trout and whitefish. In 1881, according to the statement of Mr. John Day, there were at least 12,000 half-barrels of fish salted and shipped from the island, but in 1884 the quantity did not exceed 10,000 packages. Ninety per cent. of these were marketed in Chicago, the remainder were shipped to Buffalo.

Statistics.—In 1885, 187 men were engaged in fishing, with 30 additional persons employed on shore in mending nets and icing and packing fish. Fifty-two pound-nets, valued at $23,550, 3,894 gill-nets, worth $27,814, and 4 seines were fished from the islands; these, with the other capital dependent on the fisheries, had a value of $127,376. There were 578,100 pounds of fresh fish, valued at $17,132, and 990,575 pounds of salt fish, worth $43,278, taken by the fishermen of the islands, in-

cluding 23,000 pounds consumed by the fishermen and other residents. The quantities of the different kinds were as follows: Sold fresh, 136,425 pounds of whitefish, 240,275 pounds of trout, 56,400 pounds of sturgeon, 10,000 pounds of suckers, 5,000 pounds of herring, and 130,000 pounds of miscellaneous kinds; salted, 729,175 pounds of whitefish, 261,400 pounds of trout, 44,000 pounds of herring, and 20,000 pounds of suckers. Of the fresh fish, 6,100 pounds, valued at $332, and of the salt fish 99,800 pounds, worth $4,460, were taken at the Manitou Islands. Large quantities of suckers and sturgeon are thrown away by the fishermen of this county as being unmarketable; this waste in 1885 amounting to not less than 100 tons, of which no account is taken in the foregoing figures.

Prices and trade.—The price paid for fresh fish in 1885 was 3½ cents a pound for whitefish, and 3 cents for trout, all fish smaller than one pound being discarded by the fresh fish dealers. The price for salt fish was $2.75 to $3 per half-barrel for trout, and $3.50 to $4 per half-barrel for whitefish. The fresh-fish trade is controlled largely by firms at St. James and Manistique.

Gill-net fishery.—Gill-nets have been used from the earliest settlement of the islands and are still very extensively employed, fifty-six boats with two, or occasionally three, men each, and two steamers, with a total of fourteen men, fishing with them during the greater part of 1885, besides five crews of Indians who fished occasionally. One and a half pounds of twine are used in making each net, and it measures, when "seamed," about 45 fathoms. The nets are from 14 to 18 meshes deep, and have a 4½-inch mesh for whitefish, and 5 and even 6-inch mesh for trout. Only float and stone nets were formerly employed, but these are gradually being replaced by cork and lead rigged nets, which now compose about two-thirds of the entire number. The first are worth from $5.50 to $6 when ready for fishing, and the latter about $7 to $8, according to the quality of the twine used. The boats used are almost exclusively of Mackinaw build, there being not more than half a dozen huron boats owned on the islands. The mackinaws vary from 18 to 26 feet in length. They are strongly built, and, when new, are worth $175, including sails. Two men ordinarily constitute a crew, and they use an average of sixty to eighty nets. On the Manitou Islands, however, the crews fish a smaller number. Occasionally there are three men in a crew, when from one hundred to one hundred and fifteen nets are frequently fished. The nets are set in gangs of eight to twelve each. The season begins by the 20th of April, or as soon after as the ice will allow, and many of the fishermen continue without interruption during the entire summer, though some "cut out" during September. There are no regular fishing-grounds, if we exclude the "Middle Ground," a ledge about half way between Beaver and North Fox Islands, with 8 to 10 fathoms of water, where trout are taken in considerable quantities in the fall, and Gull Island, which has long been a

favorite resort for the gill-net fishermen of the Beaver and Fox Islands, and for those of the north shore between Manistique and St. Ignace.

The Beaver Island fishermen resort to different portions of the large island and to the smaller islands, where they camp and remain during the fishing season, salting the bulk of their fish and selling the remainder fresh to the collecting boats. The catch is composed exclusively of white. fish and trout, in the relative proportion of two to one. According to figures obtained from the books of the largest salt-fish dealers on the islands, the catch of the gill-net fishermen for 1884 amounted to about 130 half-barrels to the boat, though some of the most fortunate fishermen got as high as 200 packages.

Gill-net fishing through the ice has never been extensive. It has been tried from time to time with poor results, and in the winter of 1884–'85 extensive preparations were made by one or two parties for engaging in this work, but the catch was so small as to discourage them from continuing for any extended period.

Pound-net fishery.—According to Mr. Harrison Miller, the first pound-net was brought to Beaver Island from Lake Erie in 1859. It was of small dimensions and was set in 18 feet of water in the bay, near St. James, where only a small quantity of fish was secured. The next year it was fished on the shores of High Island, and the catch there was very large. From this beginning the pound-net fishing rapidly developed, until now a very large percentage of the fish are taken in this way. The greatest increase was in 1883, when a large number of new nets were purchased. In 1885 there were twenty-three pound-nets on Beaver Island, six on High Island, four on Garden Island, one on Gull Island, two on Trout Island, one or two on the North Fox, and four on the South Fox, with two additional ones fished in the channel between Hog and Beaver Islands, and four on each of the Manitou Islands. The nets were at first quite shallow, varying from 18 to 30 feet. In 1881 a net was set in deep water and was very successful, since which time deep nets have come into general favor for spring and summer fishing, the shallowest used in 1885 being about 40 feet and the deepest 72 feet. Over fifteen of the entire number are in water of 50 feet and upwards. After the spring and summer fishing many of the nets are cut down for shoal-water fishing on the spawning-grounds, two nets often being made out of one. On account of their depth they have considerable value, the average for all the nets of the islands, according to the most reliable estimates, being about $500 each. Many complain that the mesh of the pot, or pound proper, which averages about 3 inches, and is occasionally reduced to 1½ inches, is such as to catch enormous quantities of young whitefish, and instances are cited where over four hundred in number have been required to fill a half-barrel, while the average number required exceeds two hundred and fifty. Pound-nets are fished regularly from the middle of May till late in November, with an interval of six weeks, beginning about the middle of August. Some, however, are used throughout the entire season.

The catch is composed largely of whitefish, with a few trout in May and October and a small number of sturgeon in the fall. Formerly, three or four men constituted a crew for fishing a gang of pound-nets, but now the number never exceeds three, and frequently the work is performed by two, in order to reduce the running expenses.

The Lake Ontario trap has been tried here on two occasions, and the fishermen are of the opinion that it might be introduced into the fisheries with good results, but those using them in the past have not given them a fair trial.

Seines.—Seines have been owned and operated here for over thirty years. They were at one time used along the outer beach for whitefish and herring, but none have been fished for these species since 1875. The four employed in 1885 were operated in St. James' Harbor in spring exclusively for suckers, of which about 200 half-barrels were secured.

Hand-lines.—"Bobbing" is occasionally practised by the residents of the islands, though usually only for pleasure or to supply the tables of the fishermen with fresh fish. It is hence of little commercial importance.

Set-lines.—Set-lines have been fished from time to time with fair success, and one or two fishermen have used them exclusively, in connection with herring-nets which supply the bait. Some years ago it was customary for the gill-net fishermen to use set-lines in the intervals of their other fishing. No set-lines were used on the islands in 1885.

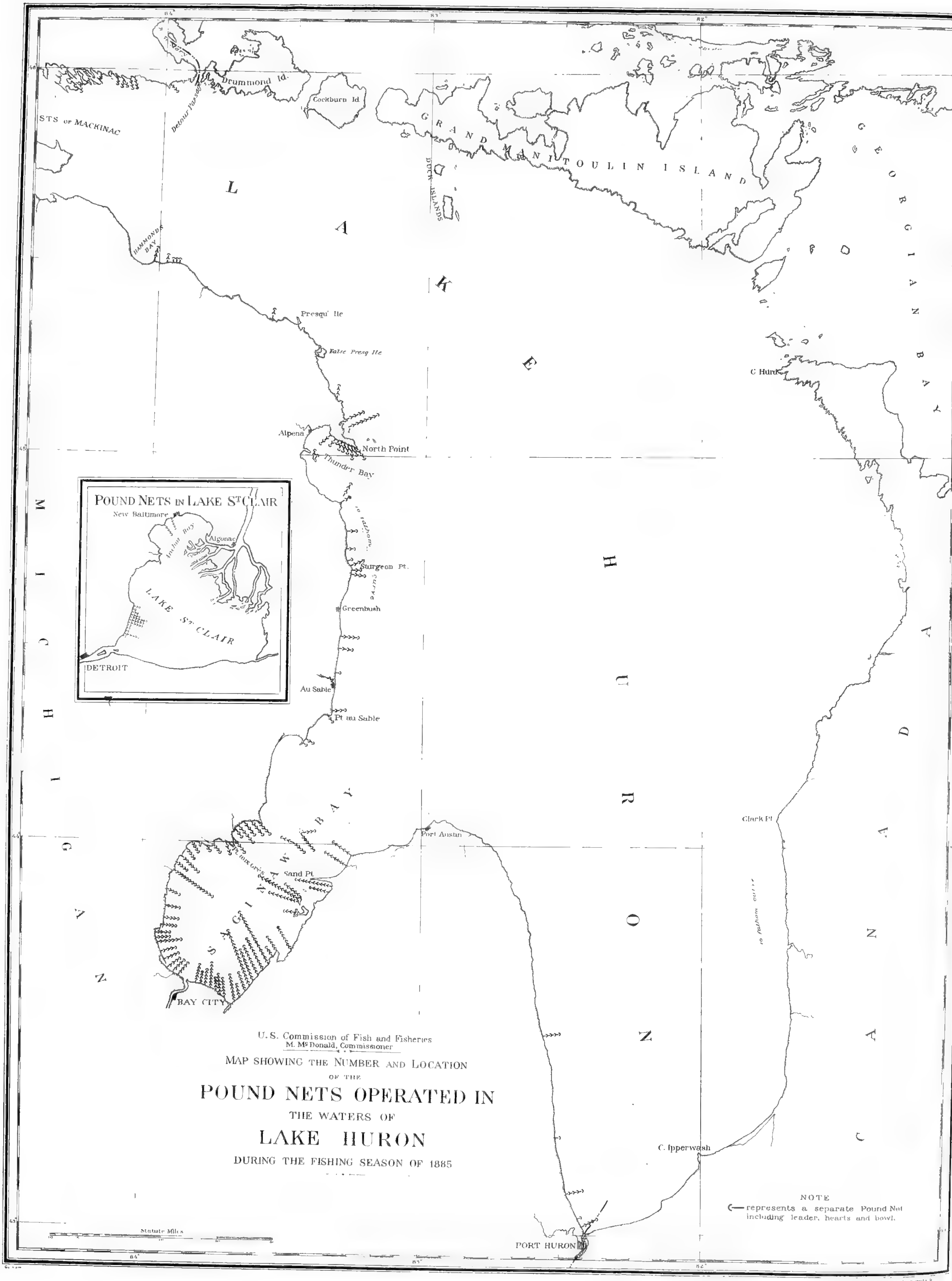
Fyke-nets, trammel-nets, and spears.—The Indians have for some years been engaged in the capture of sturgeon with spears 25 or 30 feet long, having detachable points. They paddle about in the smooth water in the vicinity of the islands watching for sturgeon, which usually lie motionless on the bottom. When one is seen the spear is lowered in the water, its position being clearly marked by a white quill which shows plainly at a depth of 30 feet. When near the sturgeon the spear is quickly plunged into its flesh, the handle becomes detached, and the fisherman seizes the line fastened to the iron and plays the fish until it becomes exhausted, when he draws it to the surface, kills it, and pulls it into the canoe. One or two Indians were making good wages by spearing sturgeon in the summer of 1885, and seven fish, averaging 65 pounds, dressed, were brought in by an Indian as the result of one day's labor. All caught in this way were formerly dried or smoked for home use, but they are now sold to the fresh-fish buyers.

No fykes or trammel-nets have ever been fished about the islands.

Dependent industries and secondary products.—Caviare and isinglass have never been prepared by the Beaver Island fishermen. Many fishermen try out the refuse fish and the waste products when dressing their fish for salting, and secure considerable quantities of oil. In 1884 between 50 and 60 barrels of oil were produced, and the following season the quantity was considerably greater.

Quite a business has been carried on for some years in the manufacture of fish barrels, and three or four parties have in the past devoted their entire time to this work. About 1860 there were annually made on the islands from four thousand to five thousand half-barrels, but the fishermen now use quantities of second-hand packages and only about two thousand new ones are made by three coopers.

The boats used in the fisheries are also built here, one man giving his entire attention to boat-building. He is assisted by others when occasion requires, though, owing to the staunchness and consequent long life of the boats, he can usually keep up with the demand without additional aid.



U.S. Commission of Fish and Fisheries
M. McDonald, Commissioner

MAP SHOWING THE NUMBER AND LOCATION OF THE
POUND NETS OPERATED IN THE WATERS OF
LAKE HURON
DURING THE FISHING SEASON OF 1885

V.—THE FISHERIES OF LAKE HURON.

72. GENERAL REVIEW.

Physical characteristics.—Lake Huron lies to the east of the southern peninsula of Michigan, and separates that State from Canada. The general contour of the lake is crescentic, and its greatest length, following the curvatures, is 280 miles. The average breadth is 70 miles, although it is 105 miles wide at the broadest part. The depth of this lake is greater than that of any other, averaging 1,000 feet. The deepest portion is off Saginaw Bay, where soundings 1,800 feet deep have been made without reaching the bottom. The waters are remarkable for their purity and sweetness, and for their clearness, which is particularly noticeable in the northwestern portion. Three thousand islands of considerable size break the surface, these being largest and most numerous along the north shore.

The American shores of the lake extend from Drummond's Island, in the upper peninsula of Michigan, to Point St. Ignace, thence southward, on the opposite side of the straits, from Mackinaw City to Port Huron, a distance of about 400 miles. Saginaw Bay is the only indentation of large proportions, although Thunder Bay, in Alpena County, deserves mention.

Population.—Along the north shore there are no settlements of note, and, with the exception of Cheboygan and Alpena, there are none in the northern half of the lower peninsula. Bay City, at the head of Saginaw Bay, is the only place of importance between Alpena and Port Huron, at the head of the St. Clair River.

The shore line of the northern peninsula is very irregular, and dotted with small islands. There is almost no resident population, although fishermen from other localities make their headquarters there during portions of the year. The more northern parts of the southern peninsula contain only a sparse population, largely dependent on the lumbering interests. Railroads do not follow the shore, and the only method of transportation is by means of the lake steamers which touch regularly at the principal points.

Alpena, it is said, is now the largest city in the United States without railroad communication. Proceeding southward towards Saginaw Bay the railroad facilities improve, but the lumber interests predominate; while still further south the agricultural occupations gradually become more extensive, and railroads touch at all the chief shore settlements.

Location of the fisheries.—The fisheries along the greater part of this shore have never been very extensive, although they have been increasing of late years; and at present important commercial fisheries occur about Alpena, while Saginaw Bay is the center of large pound and fyke fisheries. Fishing is also extensive during a portion of the year along the northern shore, where fishermen from St. Ignace, Mackinac Island, and other places are engaged in the capture of whitefish and trout with pound-nets and gill-nets. On the Canadian side very important fisheries occur in the neighborhood of the Duck Islands, in Georgian Bay, and along the northwest portion of the Canadian shore, large quantities of whitefish and trout being taken and shipped to the Detroit market.

Apparatus of capture.—Seines are employed only to a small extent, the great bulk of the fishing being carried on with pounds and gill-nets. The latter are used in considerable numbers at all the fishing centers along the American shore, and the pound-net fishing, although formerly of little consequence, is rapidly increasing, the principal centers for this fishery at present being in Saginaw Bay and Thunder Bay. The fishermen, as a rule, own the apparatus used, and ship their catch to market in a fresh condition by the lake boats or sell to peddlers, salting only such quantities as can not be readily disposed of.

Species.—The principal species taken are whitefish, trout, pike, pickerel, and herring, although large quantities of sturgeon are yearly being caught and find their way to market. In Saginaw Bay bullheads, bass, and perch form a considerable proportion of the catch in addition to the other species mentioned.

Season.—The fishing season begins as soon as the ice breaks up in the spring and continues without intermission until it forms again in the fall, or until the cold storms interrupt the fishing operations. In some localities fishing is continued during the winter months, although on a rather small scale.

Trade.—The catch from many of the fishing stations in Lake Huron is sent almost exclusively to Detroit, from which point it is shipped to different parts of the country, the dealers placing any surplus fish that they may have in refrigerators until such time as the state of the market will warrant shipment. But little business is done in fish-smoking, and the few fish thus treated are for home supply.

Table of persons employed in the fisheries of Lake Huron in 1885.

Section.	Fishermen.		Shoresmen, preparators, and mechanics.	Total number of persons employed.	Number of persons dependent.
	Professional.	Semi-professional.			
North shore of Lake Huron	68	40	27	135	218
Cheboygan County, Mich	19			19	50
Presque Isle County, Mich	21		6	27	67
Alpena County, Mich	48	6	11	65	162
Alcona County, Mich	19		1	20	50
Iosco County, Mich	21		6	27	52
Saginaw Bay and River	433	110	22	565	1,473
Lower Lake Huron	34			34	68
Total	663	156	73	892	2,140

Table of apparatus and capital employed in the fisheries of Lake Huron in 1885.

Section.	Vessels and boats.											
	Steamers.				Gill-net boats.		Collecting boats.		Other boats.		Total.	
	Fishing.		Collecting.									
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
North shore of Lake Huron	2	$10,000	3	$14,000	14	$3,300	5	$510	32	$1,945	56	$29,755
Cheboygan County, Mich					4	600			4	112	8	712
Presque Isle County, Mich					4	1,000	1	100	9	390	14	1,490
Alpena County, Mich	1	4,000			8	1,920	6	875	30	1,121	45	7,916
Alcona County, Mich					2	450			12	365	14	815
Iosco County, Mich					1	100			15	683	16	783
Saginaw Bay and River	4	13,300			1	100	3	680	381	15,310	389	29,390
Lower Lake Huron					8	1,475			11	610	19	2,085
Total	7	27,300	3	14,000	42	8,945	15	2,165	494	20,536	561	72,946

Section.	Apparatus of capture.					
	Whitefish and trout gill-nets.			Other gill-nets.		
	No.	Length.	Value.	No.	Length.	Value.
		Feet.			*Feet.*	
North shore of Lake Huron	510	278,700	$5,080			
Cheboygan County, Mich	160	31,200	1,120			
Presque Isle County, Mich	425	309,375	7,500			
Alpena County, Mich	865	581,295	11,168			
Alcona County, Mich	372	113,157	2,703			
Iosco County, Mich	62	30,690	434			
Saginaw Bay and River	305	150,975	2,890	30	7,500	$120
Lower Lake Huron	615	268,850	4,318			
Total	3,414	1,764,242	35,213	30	7,500	120

Section.	Apparatus of capture.								
	Traps.				Set-lines.			Value of minor apparatus.	Total value of apparatus of capture.
	Pound-nets.		Fyke-nets.						
	No.	Value.	No.	Value.	Length.	No. of hooks.	Value.		
					Feet.				
North shore of Lake Huron	50	$18,800						$50	$23,930
Cheboygan County, Mich	4	1,300							2,420
Presque Isle County, Mich	10	3,300							10,800
Alpena County, Mich	44	9,250							20,418
Alcona County, Mich	13	2,100							4,803
Iosco County, Mich	16	3,375							4,809
Saginaw Bay and River	440	71,925	499	$22,910	90,000	10,000	$100	40	97,985
Lower Lake Huron	9	3,300							7.618
Total	586	113,350	499	22,910	90,000	10,000	100	90	171,783

Table of apparatus and capital employed in the fisheries of Lake Huron in 1885—Cont'd.

Section.	Shore property.						Grand total of capital invested.
	Value of buildings and wharves.	Value of fixtures and accessories.	Fish-cars.		Cash capital.	Total value of shore property.	
			No.	Value.			
North shore of Lake Huron	$26,975	$1,000	70	$2,800	$22,000	$52,775	$106,460
Cheyboygan County, Mich	100	100	......	....	300	500	3,632
Presque Isle County, Mich	1,818	300	......	....	1,075	3,193	15,483
Alpena County, Mich	7,311	1,434	......	....	2,650	11,395	39,729
Alcona County, Mich	690	233	......	....	625	1,548	7,166
Iosco County, Mich	595	225	......	....	600	1,420	7,012
Saginaw Bay and River	30,535	9,350	105	1,899	26,000	67,784	194,159
Lower Lake Huron	1,175	830	......	....	....	2,005	11,708
Total	69,199	13,472	175	4,699	53,250	140,620	385,349

Table of products of the fisheries of Lake Huron in 1885.

Section.	Pounds sold fresh.							
	White-fish.	Trout.	Pike and pickerel.	Sturgeon.	Herring, bass, and bull-heads.	Suckers, perch, mullet, etc.	Total.	Value.
North shore of Lake Huron	641,370	228,200	193,700	105,000	*3,000	10,000	1,181,270	$39,303
Cheboygan County, Mich	15,400	4,000	3,600	1,000	*1,000	500	25,500	575
Presque Isle County, Mich	51,240	138,670	2,500	3,500	*2,000	1,000	198,910	6,470
Alpena County, Mich	337,050	1,203,480	40,000	14,100	*41,000	2,000	1,637,630	50,020
Alcona County, Mich	60,080	45,660	2,300	1,460	....	500	110,000	4,024
Iosco County, Mich	23,540	7,600	18,500	2,600	....	600	52,840	2,356
Saginaw Bay and River	168,500	589,000	673,000	80,640	*1,020,350 †152,500 ‡808,160	4,088,000	7,580,150	153,079
Lower Lake Huron	17,700	188,070	6,900	7,200	*30,500	600	250,970	8,403
Total	1,314,880	2,404,680	940,500	215,500	*1,097,850 †152,500 ‡808,160	4,103,200	11,037,270	294,230

Section.	Pounds salted.						Total number of pounds.	Total value of catch.
	White-fish.	Trout.	Herring.	Suckers.	Total.	Value.		
North shore of Lake Huron	69,600	59,400	....	6,500	135,500	$3,816	1,316,770	$43,119
Cheboygan County, Mich	14,000	2,000	10,000	....	26,000	920	51,500	1,495
Presque Isle County, Mich	6,400	8,500	11,000	....	25,900	890	224,810	7,360
Alpena County, Mich	18,100	46,700	104,000	....	168,800	4,931	1,806,430	54,951
Alcona County, Mich	....	12,000	16,200	....	28,200	834	138,200	4,858
Iosco County, Mich	2,400	6,500	6,600	....	15,500	376	68,340	2,732
Saginaw Bay and River	....	....	....	....	....	....	7,580,150	153,079
Lower Lake Huron	....	....	20,000	....	20,000	400	270,970	8,803
Total	110,500	135,100	167,800	6,500	419,900	12,167	11,457,170	276,397

* Herring. † Bass. ‡ Bull-heads.

73. THE NORTH SHORE (MACKINAC AND CHIPPEWA COUNTIES, MICHIGAN).

Geographical description.—That portion of the State of Michigan bordering upon the north side of Lake Huron, and constituting the so-called "North Shore," is about 60 miles in length, and extends from St. Ignace to False Detour Passage. The shore, which is for the most part rocky, is much indented with small bays and coves, and fringed with rocky islands. St. Martin's Bay, which lies northeast of St. Ignace, is the largest body of water in the section. In it are two islands of considerable size known as Isle St. Martin and Gros Isle St. Martin; while farther east is the larger island of Marquette; and finally, largest of all, Drummond Island, forming the eastern boundary of American territory. Opposite St. Ignace, in the Straits of Mackinac, are Mackinac and Bois Blanc Islands, the former being a well-populated locality from which much of the fishing along the north shore is carried on, and the latter a low, marshy island, but sparsely settled and of little commercial importance.

St. Ignace and its fisheries.—In addition to Mackinac Island, the only fishing center in this section is St. Ignace, a small community on the northeastern side of the Straits of Mackinac. It is a railroad and shipping center of some importance, and has direct steam-boat and railroad connections with the principal cities to the south, including Chicago, Milwaukee, Cleveland, Detroit, etc. Nearly one-third of the population is more or less dependent on the fishing industry.

The fishing-grounds frequented by the fishermen of St. Ignace lie to the northeast of the town in St. Martin's Bay, where nine pound-nets were operated in 1885 between the months of May and October. The nets were set in from 15 to 45 feet of water, and were fished by nine men, most of whom were French Canadians and Indians. The catch, which consisted chiefly of whitefish, amounted to 34,000 pounds, valued at about $1,300. The pound-net fishery of St. Ignace is the only one of commercial importance carried on there. About fifty men engage irregularly in ice fishing during a portion of each year, but their catch is small, amounting to only a few thousand pounds.

Mackinac Island.—Mackinac Island was settled about 1800, and now has a population of 500. Its importance is chiefly due to the fisheries centering there, and also to the fact that it has become a favorite summer resort. Notwithstanding the bold and rocky character of the shores, the harbor is an admirable one, affording good shelter for shipping. It has ample steam-boat facilities. No fishing is done in the immediate vicinity of the island, the fishing-grounds being along the north shore from St. Martin's Bay to Drummond Island.

Gill-net fishery.—Gill-nets were fished to the number of five hundred and ten in 1885. They varied in length from 360 feet to 600 feet, were 5 or 5½ feet deep, and cost $10 each. Gill-nets were introduced on the island

about 1840, at which time the fishery was carried on exclusively by Canadian French and Indians, who used board floats about 2½ feet square and stone sinkers. About 1860 cork-and-lead-rigged nets were brought to the island and the old method was abandoned. In the same year the first fishing steamer of this section was built. The size of the mesh was then the same as it is at the present time, namely, 4 to 5½ inches. In the earlier times, however, heavier twine was used, No. 30 being the kind in most demand, while now No. 50 is the size generally employed. The twine was imported from Scotland and made into nets by the women of the island. In the early history of the island, linen, which was brought from Europe for clothing, was unraveled by the women and made into primitive nets.

Pound-net fishery—The first pound set in this region was brought from Ohio about 1860, and was located in the Straits of Mackinac, costing when completed $1,500. Forty-one nets, operated by Mackinac parties, were fished along the north shore in 1885. Eight were set in St. Martin's Bay and vicinity and the others in stands of one to three between Marquette Island and Detour Passage and on Drummond Island. The fishing season for most of the nets was from May to October, although some were put in as early as April 15 and not taken up till December 1. September and October are the best months for fishing along this shore. The nets were fished in water from 20 to 62 feet in depth, and required the services of three to five men to each stand. The nets were valued at from $300 to $400 each, and stocked about $125 each in 1885 on whitefish, trout, and pike, the first-named species being most numerous.

Seines and spears.—Seines were introduced about 1840, but were not a success, and were abandoned; later attempts to make the use of seines profitable have also failed. In the early history of the place the Indians were largely dependent on their spears for their fish supply, and that kind of apparatus was extensively used; of late years, however, no spearing of fish has been done.

Species.—Whitefish is the most abundant species taken in this region, the quantity caught being more than that of all the other kinds combined. Trout rank next in importance, closely followed by pike and pickerel. Sturgeon are fairly numerous. Suckers and herring complete the list of marketable species, neither being taken in any considerable quantities.

Prices.—The prices received by the fishermen for their catch vary from one-half to 4½ cents a pound, according to the species. Whitefish command the highest prices, 3 to 3½ cents being the prevailing rates for fresh fish. Trout, pike, and pickerel bring about 3 cents. Sturgeon are sold at 75 cents apiece. Herring are worth 2¼ cents, and suckers and other minor varieties from one-half to 2 cents. Salt whitefish are sold at 4 to 4½ cents, salt trout at 3 cents, and salt suckers at one-half cent a pound.

Dealers.—One firm at St. Ignace and one at Mackinac Island are the only dealers in fish in this region, and they handle a large proportion of the catch of the fisheries on either side of the Straits of Mackinac, but especially those on the eastern side. These firms employed twenty-seven men in the capacity of collectors of fish, shoresmen, preparators, and mechanics; kept three steamers engaged in visiting the fishing-grounds and collecting fish; had $25,800 invested in wharves, buildings, fish-cars, etc., and $14,000 in fishing steamers, and bought and shipped in 1885 about 1,600,000 pounds of fish, valued at about $60,000. The firm on Mackinac Island located there in 1875, and began shipping fresh fish packed in ice to Chicago by steamer. In 1885 they built a freezing apparatus, with a capacity of 40 tons, which will enable them to utilize many fish that would otherwise have to be salted or sold fresh at a loss.

Markets.—The fish which are landed at St. Ignace for shipment are sent to Chicago, Detroit, Cleveland, Cincinnati, and Buffalo, the greatest amount going to the first-named place, except in winter, when Cincinnati gets the great bulk of the trade. In the early days of the Mackinac Island fisheries, the fish were all salted in barrels containing 200 pounds and shipped by steamer to Buffalo and Cleveland. Mr. James C. Rice (one of the earliest fishermen in this region), in 1857, when very heavy fishing was done, shipped on an average 2,000 half-barrels of salt fish weekly. In 1841 he traded fish for flour, barrel for barrel, in Chicago. In 1845 he began shipping fresh fish to Cleveland, in fish-cars of about half the size now used, holding 1,500 pounds of fish packed in ice. At that time fish were bought by the piece, the price for whitefish being about 5 cents each; trout were larger then than now, ranging from 10 to 40 pounds; the largest one ever taken weighed 84 pounds. The price for trout at that time varied from 10 to 50 cents. Since 1857 a large part of the catch has been sent to Chicago.

Statistical summary.—The number of men employed in connection with the fisheries in this section was 135, of whom 68 were professional fishermen and 27 men, as already stated, were engaged by the dealers to collect and handle fish. Two hundred and eighteen people were dependent on the fisheries in addition to those before mentioned.

The apparatus used consisted of 2 fishing steamers and 3 collecting steamers, valued at $24,000; 14 gill-net boats, 17 pound-net boats, and 15 other boats, valued at $5,755; 510 gill-nets, 278,700 feet in length, valued at $5,080; 50 pound-nets, valued at $18,800; and miscellaneous apparatus and accessories, including fish-cars, valued at $3,850. The shore property was worth $26,975, and the cash capital amounted to $22,000. The total capital invested was $106,460.

The catch in 1885 amounted to 1,181,270 pounds of fresh fish and 135,500 pounds of salt fish, valued at $39,303 and $3,816, respectively. The quantities of the different species were 641,370 pounds of whitefish, 228,200 pounds of trout, 193,700 pounds of pike and pickerel, 105,000

pounds of sturgeon, 3,000 pounds of herring, and 10,000 pounds of mixed fish, sold fresh; the salt fish consisted of 69,600 pounds of whitefish, 59,400 pounds of trout, and 6,500 pounds of suckers. The secondary products were 1,500 gallons of fish oil, valued at $450.

74. CHEBOYGAN COUNTY, MICHIGAN.

General description.—The shore-line of Cheboygan County stretches for a distance of 20 miles southeast of Mackinaw City, terminating at the northern extremity of Hammond's Bay. The only community of importance on the lake is Cheboygan, a town of about 2,000 inhabitants, situated at the mouth of the river of the same name. The fisheries of the section are of comparatively little value, consisting only of a limited amount of pound-net fishing on that portion of the shore opposite the South Channel, and some gill-netting about 17 miles northeast of Cheboygan on Spectacle Reef.

Pound-net fishery.—Pound-nets have been set along this shore since 1861. In 1885 four nets were operated, two by Cheboygan parties and two by men living at Mackinaw City. The nets, which had a $2\frac{3}{4}$-inch mesh, were set in from 28 to 40 feet of water and remained in use from July to November. They were worth from $300 to $350 each. Seven men, in two gangs, with two pound-net boats and two other small boats were required to fish the nets; they were French Canadians, and were hired at the rate of $26 a month by the owners of the nets. The average stock of the pounds in 1885 was $225, made up chiefly of sales of whitefish and herring.

Gill-net fishery.—This is carried on by a Cheboygan man who employed one hundred and sixty nets and four gill-net boats, engaging the services of twelve men from May 1 to September 1, and again from October 1 to November 20. The nets are about 195 feet long and 6 feet deep, and cost $7 each. The yield in 1885 was 20,000 pounds, chiefly whitefish, which were sold fresh for $600.

Statistical résumé.—Nineteen men were engaged in fishing in Cheboygan County in 1885. The apparatus included 8 boats, valued at $712; 4 pound-nets, valued at $1,300; 160 gill-nets, valued at $1,120; and miscellaneous apparatus, shore property, and working capital, valued at $500; the total amount invested in the fisheries being $3,632. The catch consisted of 15,400 pounds of whitefish, 4,000 pounds of trout, 3,600 pounds of pike and pickerel, and 2,500 pounds of other fish, sold fresh; and 14,000 pounds of whitefish, 2,000 pounds of trout, and 10,000 pounds of herring, salted; the products being valued at $1,495.

75. PRESQUE ISLE COUNTY, MICHIGAN.

Physical characteristics.—The shore of this county is about 45 miles long and extends from the upper side of Hammond's Bay on the north to (but not including) Middle Island on the south. It is generally low and sandy, with very shallow water. An occasional bluff

occurs, and in the lower portion in the vicinity of Presque Isle and southward the soil is gravelly and the land generally high, while the water is in some places quite deep close to the shore. The only good harbor is at Presque Isle, though at Thompson's Harbor and other places there are well sheltered but shallow inlets which afford protection to small boats.

Population.—There are no large towns in the county. The coast settlements are Spencer's Dock, Rogers City, Crawford's Quarry, Thompson'sHarbor, Presque Isle, and Bell. The population is largely dependent upon the lumber trade, and in the vicinity of the settlements there are a good many scattered farm-houses.

Gill-net fishery.—Gill-nets were first used from the present site of Rogers City in 1862, at which time both whitefish and trout were very abundant. In 1867 the apparatus was introduced at Crawford's Quarry. Stone and float nets were at first used, but of late they have been generally replaced by those rigged with corks and leads. The fishery at Crawford's Quarry grew to be quite important, but was altogether abandoned in 1879 when the fishermen moved to Rogers City, which has a better harbor and is more frequently visited by the steamers. In 1885 the only gill-net fishing was from Spencer's Dock and Rogers City, and chiefly from the latter place. The fishing ground is a strip about 2 miles distant from the shore, from 5 to 10 miles wide and extending from a spot 16 miles north of Rogers City to another 12 miles south of that village. The bottom is of sand and clay, and the depth of the water varies from 12 to 60 fathoms. About three-quarters of the fish taken are trout, and the rest whitefish. The fishing is carried on two months in the spring and three in the fall, generally from the early part of April to the beginning of June, and from the 1st of August to the last of November. The nets used are from 500 to 750 feet long and 6 feet deep. The web and line is usually obtained from the fish dealers at Alpena, and is made into nets by the fishermen during their leisure hours at home.

Pound-net fishery.—Fishing with pound-nets has been carried on in a small and desultory way at Presque Isle and vicinity since 1860. At other places in the county they were not introduced until 1885. In August of that year five nets, from 28 to 37 feet deep, were put in at points on Hammond's Bay from 14 to 16 miles north of Rogers City. They are set on a sandy bottom for whitefish, pickerel, and herring. Three nets were set about the same time at Spencer's Dock, 12 or 13 miles north of Rogers City, in from 42 to 50 feet of water. At Thompson's Harbor they were introduced at the same date by a firm from Bay City, Michigan, whose two nets were set in water 27 and 39 feet deep, on sand and clay bottom, for the purpose of catching whitefish and pickerel. All of these pound-net fishermen expected to get their most productive fishing in the spawning season, which extends through the greater part of the month of November.

Trade.—Almost the entire catch was formerly salted and disposed of locally or sold to traders for shipment to Alpena, Detroit, and other lower lake ports. Since the building of the first steam-boat dock at Rogers City in 1872 most of the fish have been shipped fresh in cars to Detroit, though some have each year been salted before shipment, and a few fresh fish have been sold locally, the amount so disposed of in Rogers City and its vicinity being 2 or 3 tons annually. At Presque Isle the fish were all salted until 1884, the last year of the fishing there, when they were shipped fresh to Alpena.

Occupation and lay of fishermen.—There is no fishing during the winter in this county and most of the fishermen work at that season in the cord-wood and cedar camps. Some of the pound-nets and gill-nets are fished on shares, the owner furnishing the boats and nets complete and material to keep them in repair. The operator pays all running expenses including repairs on nets and boats. The fish are all sold to one firm and the money equally divided between owner and operator.

Statistics.—The number of men engaged in fishing during 1885 on the lake shore of Presque Isle County was 21, of whom 6 were in the pound-net fishery exclusively, 12 in the gill-net fishery only, and 3 in both fisheries. Six shoresmen and preparators were also employed in connection with the gill-net fishery. There were 10 pound-nets, worth $2,300, and 425 gill-nets, worth $7,500. The value of wharves and buildings amounted to $1,818, and that of minor apparatus and accessories to $300, the working capital being $1,075. The yield consisted of 224,810 pounds of fish, of which 198,910 pounds were sold fresh, including 138,670 pounds of trout and 51,240 pounds of whitefish. The salt fish were 11,000 pounds of herring, 8,500 pounds of trout, and 6,400 pounds of whitefish. The catch was valued at $7,360.

76. ALPENA COUNTY, MICHIGAN.

Geographical description.—The shore line of Alpena County is a little less than 50 miles in length, and includes Middle Island on the north; and South Point, the lower boundary of Thunder Bay, on the south. The water is generally shallow, and the shores are low, except at Partridge Point in Thunder Bay where the shores are quite abrupt with deep water near the land. Thunder Bay forms a very large and excellent harbor, well sheltered against all but easterly winds; wharves may be built on almost any portion of its shores and do not have to be of great strength to withstand the waves. The beach is of sand, gravel, or stone, shelving gradually toward the open lake. The bottom is almost free from obstructions to navigation, the only reef being a small one about half a mile from North Point.

Between Nine Mile Point and North Point there are many small semicircular bays, usually about half a mile wide, which form good harbors for small fishing boats that do not draw over 3 feet. Just above North Point is Little Thunder Bay or Misery Bay. Its shore is low and

sandy, and although it is a safe and roomy harbor it is inaccessible to boats drawing over 6 feet of water. Mr. Wires says that Little Thunder Bay is one of the best locations on the west shore of Lake Huron for penning whitefish to obtain their spawn. Abreast of North Point, and about 3½ miles distant, is a group of small islands, consisting of Thunder Bay Island, Sugar Island, Gull Island, and several little islets yet unnamed. A reef, which is in some places as shoal as 4 fathoms, runs from Thunder Bay Island to Middle Island, at a distance of 4 miles from the mainland, and protects the shores between North Point and Nine Mile Point from heavy seas. On this reef whitefish spawn in November. Outside the reef the lake bed sinks rapidly and in places almost abruptly, till it reaches a depth of from 20 to 40 fathoms.

Early and present population.—A few fishermen and hunters located themselves temporarily within the limits of the present county of Alpena about the year 1835, and between that time and 1856 a few fishermen settled on Thunder Bay Island and Sugar Island, but the region was sparsely populated until 1856, when Alpena City was located and partly surveyed. The entire population of Alpena County amounted to only 12,717 in 1884, according to the state census, and of these 9,210 were residents of Alpena City. This place is situated on both sides of Thunder Bay River, at its mouth. There is a dam about a mile up the river, and the channel below forms a perfectly sheltered harbor.

The only other settlement on the lake coast of the county is Ossineke, 12 miles south, a little hamlet of 100 inhabitants.

History of the fisheries.—The first fishery prosecuted from these shores was inaugurated in 1835, when John Muncy located at Thunder Bay Island and began fishing with stone and float gill-nets. In 1836 another man followed his example at Middle Island. Fishing has been carried on more or less regularly at different places in the county from that time to the present. In 1858 pound or trap-net fishing was introduced from Ohio, and a net was set at Whitefish Point, about 4 miles northeast of Alpena.

Causes of decreased abundance of fish.—At first whitefish and trout were both abundant, and fishermen found no difficulty in catching with a few small gill-nets as many fish as they could sell. But since 1881 or 1882 they have been comparatively scarce. Various causes are given for this decrease. The gill-net fishermen lay the blame on the small-meshed pound-nets. The pound-net fishermen, on the other hand, throw the responsibility upon the saw-mills and the gill-net men. The saw-mills, they say, pollute the waters with sawdust and vegetable refuse, and the gill-net men lose a great many nets, which, with the fish in them, soon decay and become a putrid mass which contaminates the fishing grounds and causes the fish to leave for other places. Mr. S. P. Wires reports: "On two questions they all agree. First, twenty years and less ago the waters on the shores of Alpena County swarmed with whitefish and trout. Second, to-day these fish are not

abundant. In 1883 the trap-net grounds of Thunder Bay failed for the first time, and the fishing in 1884 was equally as bad."

The same authority says that in his own opinion (as one interested in the fisheries, but not actively concerned either with gill-nets or trap-nets) the decrease is owing mainly to excessive and unwise fishing, especially during the spawning season. When whitefish were abundant their favorite spawning ground was a shoal about 5 miles from the shore, which they visited in countless numbers during the month of November. On this ground it was not an uncommon thing to catch in one net 200 pounds of whitefish during a single night; and boats often returned to their fish-houses with from 20 to 30 barrels, taken at a single lift from a gang of twenty or more gill-nets. During a season hundreds and thousands of barrels of whitefish were thus caught, the females being full of spawn which was left to rot in the offal pile. The water on the spawning ground is 5 or 6 fathoms in depth, and being fully exposed to the seas that roll on Lake Huron in November, is stirred to the bottom whenever a gale is raging from the northeast or southwest. At such times hundreds of gill-nets loaded with fish were swept away and never recovered by the fishermen, but remained on the bottom polluting the waters. Mr. Wires further states: "Weeks before the spawning season commenced, the gill-nets and trap-nets had been at work catching fish full of unripe spawn. Is it, therefore, any wonder that whitefish have decreased in numbers, and that once valuable fisheries have become almost barren and worthless?" He says the fishermen look to artificial propagation to restore the abundance of fish in this locality.

Fishing stations.—The fishing at present is scattered along the whole coast of the county from Middle Island to Scarecrow Island. At Ossineke, where there were large pound-net fisheries for many years, the results since 1882 have been so poor that there was not a single net set there in 1885. No gill-net fishing has ever been carried on from that place. Middle Island is low and sterile, and is inhabitated only by a United States life-saving crew and a few fishermen, who find here a very good harbor for their little boats. The beach is gravelly and the water shallow. Gill-nets are set on the rocky and gravelly bottom, near the island, for whitefish and trout. The season for trout begins September 20, and for whitefish during the month of November. Nine Mile Point is inhabited only by fishermen. At the extreme end its shore is rocky and the water deep, but elsewhere it is low and sandy, with irregular outlines and very shallow waters. There is a good harbor for fishing-boats. Pound-nets were introduced here in 1884, and are set on clay ground for whitefish, pickerel, bass, herring, and sturgeon, but only small results are secured. A number of pound-nets are located at Round Island, an islet at the mouth of Little Thunder Bay. Some pickerel, bass, and herring are taken in these, though the catch is principally whitefish, which are most abundant here before the begin-

ning of the spawning season. The next fishing stations are Sugar and Thunder Bay Islands. Sugar Island is populated only by a half a dozen fishermen and their families, while on Thunder Bay Island the only buildings are the United States light-houses and life-saving stations. Gill-net fishing has been carried on here for over half a century. Prior to 1859 it was confined to Thunder Bay Island, but in that and the following year the fishermen all moved to Sugar Island, on account of the better harbor facilities there; and since that time there has been very little fishing done on the former. Most of the fish caught at Thunder Bay Island are "shoal-water" trout.

The Sugar Island fishermen catch whitefish and trout, most of the former being obtained during the spawning season, several gill-net crews having their shanties on North Point, which otherwise would be entirely uninhabited. They catch whitefish on the shoals north of Thunder Bay and Sugar Islands, making their best hauls in the spawning time, and trout are taken on the shoals southeast of the islands. From the extremity of North Point the upper side of Thunder Bay is lined, for several miles to the east, with pound-nets. Whitefish are seldom caught along the northern and western shores of Thunder Bay during the spawning season, and there has been in the last few years a growing scarcity at all seasons. The pound-net fishery at Whitefish Point, near Alpena, has been discontinued, but there is still a little gill-net fishing, and at Partridge Point, 4 miles south of that town, there is a large pound-net fishery. The most southerly point in Alpena County where the fisheries are prosecuted is Scarecrow Island, about 3 miles north of South Point and 8 miles east of Ossineke, and surrounded by very shallow water. It has for many years been the site of a pound-net fishery, which is here found most profitable during the whitefish spawning season.

Trade.—Up to 1872 the entire catch, except the small portion retained for local use, was salted before shipment and packed in half-barrels of 100 pounds each. In that year one firm began to pack fish in ice and ship them fresh. At present almost all are sold in Alpena and shipped fresh from that place to Detroit or sometimes to Bay City. The herring are commonly salted, but aside from this species the percentage so prepared is exceedingly small. Sometimes the fish are placed side by side in shallow tin pans and frozen before shipping, but this method is not in very general use.

The fish to be shipped fresh have their viscera and gills removed but the heads are left on.

They are usually packed in four-wheeled wooden cars with a capacity of 2,000 pounds. These cars have double sides, inclosing an air-chamber, and a portion of the top and of one side of each car is removable. For job lots smaller cars are used, and when there are no cars on hand or there are not enough fish to fill a car they are sometimes packed instead in rough wooden boxes holding a few hundred pounds each.

Crushed ice is placed on the bottom of the car and a row of fish side by side is laid upon it, then another layer of crushed ice and so on, the layers of ice and fish alternating until the car is filled. In this way fresh fish can be sent in perfect condition for hundreds or thousands of miles.

Alpena having no railroad connections, all the fish are shipped by steam-boat. During the season of navigation there is a line of steamers running to Bay City and Detroit. A few years ago whitefish and trout were the only species marketable, and sturgeon were generally thrown into the offal pile, while herring were considered a nuisance on account of the extra work required to clear the pound-nets of them. The principal demand is still for the whitefish and trout, but sturgeon, bass, pickerel, herring, and suckers all sell readily now, some of them bringing good prices. The amount of fish shipped in 1883 is reported to have been 1,932,000 pounds, of which 262,000 pounds were brought from the Duck Islands, Ontario. The quantity for 1884 is estimated at 2,200,000 pounds.

Statistics.—The total number of fishermen in 1885 was 54, nearly all Americans or Canadians, of whom 12 were engaged in the pound-net fishery only, 20 in the gill-net fishery only, and 22 divided their attention between the two. The amount of capital invested was $20,745 in the pound-net fishery and $18,984 in the gill-net fishery. The product amounted to 1,806,430 pounds, worth $54,951, of which 355,150 pounds were whitefish and 1,250,180 pounds were trout; the remainder was made up of 145,000 pounds of herring and 56,100 pounds of other fish. Of these, 18,100 pounds of whitefish, 46,700 pounds of trout, and 104,000 pounds of herring were salted, the total salted products having a value of $4,931. All the rest were sold fresh.

Pound-net fishery.—Since the introduction of the pound-net in 1885 this apparatus has been used continuously in different portions of Alpena County. In 1859 it was introduced at Scarecrow Island, where it has been used extensively ever since, there being 5 pound-nets there in 1885. On the south side of North Point the first pound-net was set in 1859 by a man who brought it from Sandusky, Ohio, and since that time there have been from 1 to 9 nets here, the latter number being operated in 1885. A little to the westward, on the north side of Thunder Bay, pound-nets have been set annually since 1867, the number varying from 2 at the outset to 9 in 1885. The first pound-net at Partridge Point was in 1862, and there were 3 nets there in 1885. At Round Island there was no fishing prior to 1883, when there were 3 nets set, which, meeting with fair success, were followed by 8 in 1884 and 12 in 1885. Finally, Nine-Mile Point had 3 nets, which were first set in 1884.

The nets range in depth from 24 to 46 feet, and the pots are from 30 to 35 feet square. The size of mesh has decreased of late years. The sizes now in use are 1½, 2, 2½, and 3 inches. The smaller sizes do not permit

many fish to escape, holding those that are hardly large enough to be marketable. The boats used are flat-bottomed skiffs, carrying two fore-and-aft sails. The fishing season usually begins the 1st of June, but in some cases not until August or September, and always lasts until about the end of November.

The total number of pound-nets in 1885 was forty-four, with a value of $9,250. The value of the pound-net and collecting boats was $1,665, that of the shore-houses was $3,050, and that of other apparatus and accessories $1,119, the cash capital being $1,500.

Gill-net fishery.—Gill-nets have been more or less extensively used ever since their introduction in 1835. In 1844 a number of men came from New York and Ohio and engaged extensively in gill-net fishing from Thunder Bay Island, but since 1860 there has been almost no fishing there, and at present it has only one crew with fourteen gill-nets. At Sugar Island, where the fishing began in 1859, there are now two crews, with one hundred and eighty nets in all. The other places which have a gill-net fishery are the following: Middle Island, five crews; north side of North Point, four crews; Alpena, one steamer crew. Three of the Middle Island crews began fishing for the first time in 1885.

At the outset of the fishery the nets used were of poor quality. They were short, were made of coarse twine, and were kept in position on the bottom of the lake by means of floats and stones. In those days only from five to eight nets were fished in a gang. In recent years the float and stone rig has been usually replaced by corks and leads, and the length of the nets, as well as the size of the gangs, has been much increased. The gangs used by the steamers contain about forty nets, each about 835 feet long, so that it takes four hours to lift the whole gang. The nets for the whole region range from 330 feet to 740 feet in length and 3 to 6 feet in depth, the larger sizes being the more common. The size of the mesh is usually $4\frac{5}{8}$ inches.

The sail-boats used in fishing the nets are from 26 to 32 feet long, with 8 or 10 feet beam, and draw from 2 to 3 feet of water. They are clinker built and have two masts with two fore-and-aft sails. Their speed is excellent and they are good sea-boats, capable of working well against the wind. There are usually three men in a crew, but sometimes only two.

The first steam-vessel fishing in the waters of this county was the *Lida*. She was used in 1875 on the shoals north of Thunder Bay Island and on the Big Reef. The latter is about 40 miles out from the land at Alpena and is a favorite feeding and spawning ground for trout, though whitefish are very scarce there. The best hauls are made during the spawning season, from October 25 to November 30. The use of steamers increased until at one time as many as six made Alpena City their headquarters. The steamers do not remain at Alpena the entire season, but generally fish off that place only in the fall. In 1885 the *Walter L. Davis* was the only one employed.

The crew of a fishing steamer consists of a captain, at from $75 to $100 per month, an engineer, at from $75 to $85 per month, and five men, at from $25 to $50. Among the sail-boat fishermen the most common practice is for the owner of the fishing rig to hire his men by the month, and furnish them board and lodging, paying, in addition, an average of $65 per month to the "boat-runner," or captain, and $25 or $30 per month to the other men in the boat. Shore hands, who have to mend the nets, get a little more than ordinary boat-men, their wages being according to their skill. Sometimes the outfit is rented for a fixed sum or fished on shares.

The men who fish on a small scale occasionally knit their own nets in the winter, but only a few do this. Almost all the netting is obtained from the fish buyers. The fishermen do their own seaming, and attach the corks and leads. When float and stone are used the fishermen select stones about 3 inches long and $1\frac{1}{2}$ to $2\frac{1}{2}$ inches thick and chip them at the sides to form a shallow groove in which the string is tied that holds the stone to the net. The floats are a little over 2 feet long, $1\frac{1}{2}$ inches wide, and half an inch thick. These are prepared at times when the weather is not suitable for visiting the fishing-grounds. When floats and stones are used the nets are hung on posts to dry, but cork-and-lead nets are wound upon reels for that purpose.

In 1885 the fishermen used 8 gill-net boats, valued at $1,920, and 865 nets, worth $11,168. The shore houses had a value of $4,261, and other apparatus and accessories $315, the cash capital being $1,150.

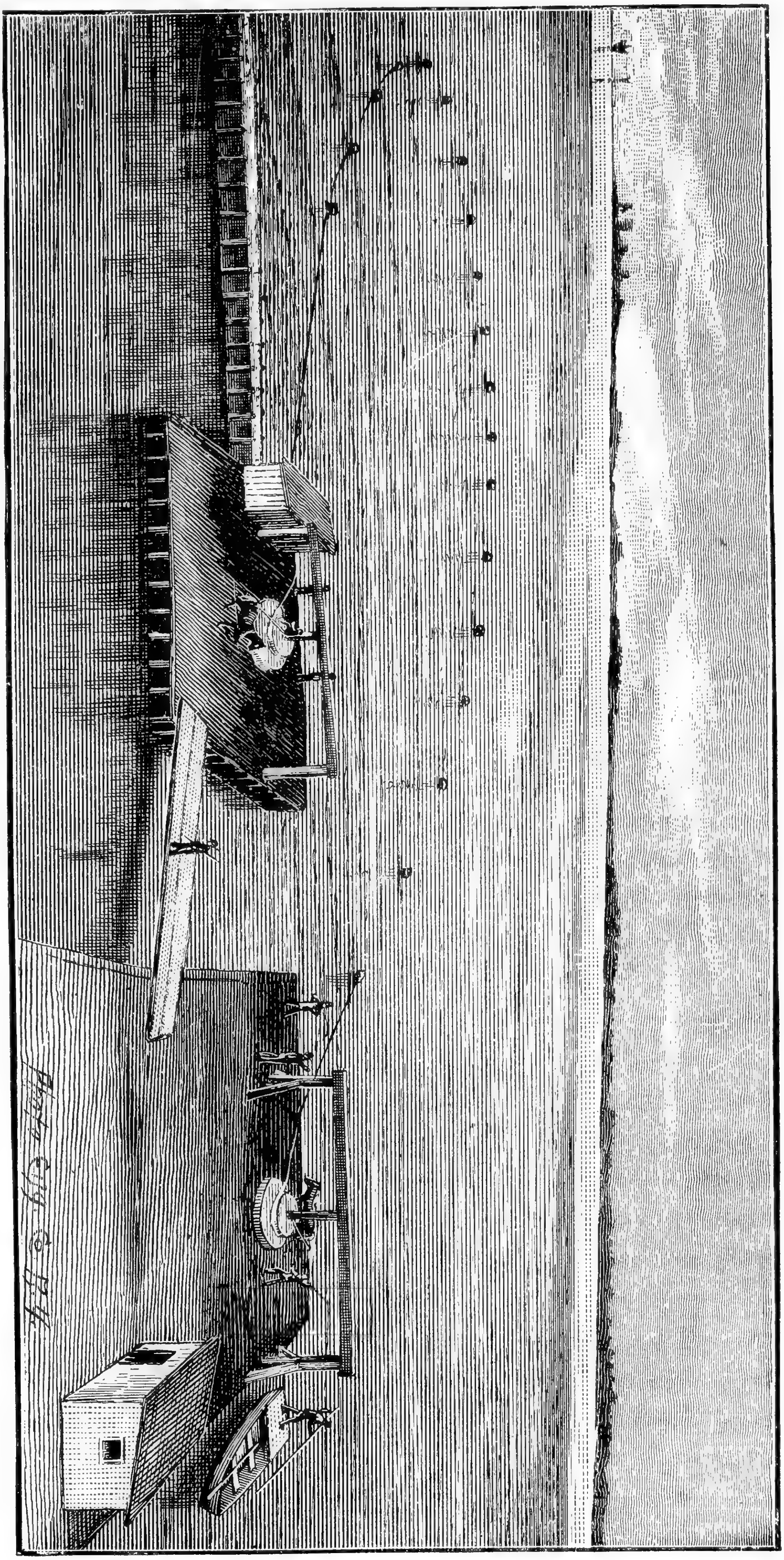
Other fisheries.—The "shoal-water" trout in this region begin to spawn in the latter part of September. Their favorite resorts are the rocky shallows near Middle and Thunder Bay Islands. They are fat and well-flavored, and weigh 5 or 6 pounds. On pleasant nights during the spawning season a good many of these trout are speared, but this is not carried on as a business and is not of sufficient importance to be included in the statistics.

77. ALCONA COUNTY, MICHIGAN.

Physical characteristics.—Alcona County has a shore line over 20 miles in extent. The water is usually extremely shallow near the land, with a rocky bottom. The shore is generally low and sandy, but at Greenbush and Harrisville it begins to rise rapidly a short distance from the water.

Coast hamlets.—There are only four villages on this piece of coast, if we exclude Sturgeon Point, where there are a United States life-saving station, light-house, and a few shanties. These are Alcona, Greenbush, Harrisville, and Black River, with a population of 150 to 500 each.

History of the fisheries.—The earliest recorded fishing in this county was at Alcona, where, in the first year of its settlement, gill-nets were brought from New York State by William Hill, and this form of apparatus has been in continuous use ever since. The next season (1849) William



HAULING IN HERRING SEINE IN THE DETROIT RIVER. INCLOSURE FOR KEEPING FISH ALIVE.

Sketch by L. Kumlien.

Cilling located at the mouth of Black River for the purpose of gill-net fishing, but caught so few fish that he soon abandoned the experiment, which has been several times since repeated at the same place on a small scale, but uniformly without success. In 1850 gill-net fishing began at Sturgeon Point and continued until about 1875. Gill-nets were introduced at Greenbush in 1854, and were in use until 1881. Pound-nets also made their first appearance in Alcona County in 1854. Harrisville had a gill-net fishery from 1859 to 1883.

Character of the fisheries.—The only fisheries at present in operation are carried on by residents of Alcona and Harrisville. Alcona has four gill-net crews, and ten pound-nets owned at that village are scattered along the shore from within a mile or two of Black River to the south side of Sturgeon Point. Four pound-nets were set at Harrisville in 1884, and in 1885 three owned at that place were fished about a mile south of Sturgeon Point. The fishing ground for the gill-net crews is about 6 miles from the shore and is 16 miles long and 8 miles wide, with bottom of rock, sand or clay.

The principal change which has taken place in the fishing is the substitution of the cork and lead method of hanging gill-nets for the stone and float rig which was at first universal.

Species.—The chief species caught are whitefish and trout, but pickerel, herring, and sturgeon are also taken. On the gill-net grounds comparatively few whitefish are obtained, while around Sturgeon Point they are much more numerous than any other species. The kinds of fish named were at first very abundant, but their great decrease has caused the extinction of most of the old fisheries. Even at Alcona, where the fishermen still ply their trade, the catch has been light since 1882. The whitefish are more abundant during the spawning season than at any other time.

Trade.—Up to 1875, all or nearly all of the fish taken were salted and sold to traders, who took them to Detroit and other lower lake ports. Since that date the custom has been to ship the catch fresh in cars from Alcona to Detroit and Port Huron. The herring and a few packages of other fish are still salted for shipment, and from 4 to 7 tons per annum of fresh fish are used locally.

Statistics.—The total number of men employed in the fisheries of this county in 1885 was 25, 24 of whom were fishermen, whose 15 pound-nets and 372 gill-nets had a combined value of $4,803; their boats, $815, and their shore property and accessories, $923; the working capital amounted to $625.

The catch was valued at $4,858, and was as follows: Sold fresh, 60,080 pounds of whitefish, 45,660 pounds of trout, 2,300 pounds of pike and pickerel, 1,460 pounds of sturgeon, and 500 pounds of miscellaneous species; salted, 16,200 pounds of herring and 12,000 pounds of trout.

78. IOSCO COUNTY, MICHIGAN.

Geographical description.—Iosco County is about 35 miles long. It is generally high or hilly, with a low, sandy beach intervening near the water in the district north of Ottawa Point. The water is deep at the mouth of Sable River and in Ottawa Bay, but elsewhere it is usually quite shallow near the land.

Towns and industries.—There are five villages on this coast, each with its own post-office, four of which are on the line of a new railroad. These are, in their geographical order, beginning at the north, Oscoda and Au Sable, both settled in 1849, and with a population in 1885 of 3,500 each; East Tawas, settled in 1864, population 1,850; and Tawas City, settled in 1853, population 1,000.

Location of the fisheries.—There have been fisheries with gill-nets and pound-nets in this region since its first settlement. The fishing is carried on at different places scattered along the shore, each owner of a fishery having one or more shanties on the spot which he considers best adapted for the work, where he resorts with his crew during the fishing season. There are six of these fisheries outside of the villages, and at all of them pound-nets are now exclusively used. Two are near the northern county-line, two on Point Au Sable, and two on the east side of Ottawa Point. One of the first-named has been in operation since 1860, and one of those on Point Au Sable since 1865. The others have all been established during the last three years (1883–1885). As early as 1849, the year the villages of Oscoda and Au Sable were settled, gill-nets were used therein; and, though fish have been scarce for the last eight or ten years, Au Sable still had one gill-net crew and one pound-net in 1885. The gill-nets are set from 3 to 16 miles out from the shore, in from 12 to 40 fathoms of water. At Tawas City and East Tawas gill-nets were introduced by a firm from Bay City, and were first used in 1850 and 1851, while pound-nets were introduced in 1860. In 1868 fish of all kinds became very scarce, and since that date no pound-nets have been fished and only a very few gill-nets. At present there is no fishing there, and none at Alabaster, where it was carried on with pound-nets on a small scale from 1865 to 1884.

Species.—The catch consists of whitefish, trout, bass, herring, pickerel, and sturgeon, but principally of whitefish and herring. The whitefish are taken most abundantly during the spawning season. At Point Au Sable they have been scarce for a number of years, and herring are now almost the only species taken there.

Trade.—Prior to 1868–'70 the fish taken, aside from the small quantity used in the vicinity, were all salted and sold to traders for shipment to Bay City, Detroit, and ports on Lake Erie. Since that date nearly all those which are not sold to the village trade are, with the exception of the herring, shipped fresh in cars and boxes to Bay City, Port Huron, and Detroit, and the salted herring are sent to the same places. At present the local consumption of hard fish at Oscoda and Au Sable amounts to between 8 and 10 tons annually.

Statistics.—The total number of fishermen on the shores of Iosco County in 1885 was 21, who operated 16 pound-nets, worth $3,375; 62 gill-nets, worth $434; 16 boats valued at $783; had shore property and accessories valued at $820, and a cash capital of $600.

These fishermen caught 23,540 pounds of whitefish, 18,500 pounds of pike and pickerel, 7,600 pounds of trout, and 3,200 pounds of other fish, which were sold fresh; they also took 6,600 pounds of herring, 6,500 pounds of trout, and 2,400 pounds of whitefish, which were salted. The total yield was valued at $2,732.

79. SAGINAW BAY AND RIVER (ARENAC, BAY, TUSCOLA, AND HURON COUNTIES), MICHIGAN.

Bay City.—The capacious arm of Lake Huron which bears the name of Saginaw Bay, while it has a number of post-office settlements on or near its shores, has not a single large town, but upon the river of the same name which flows into its head are several places of considerable importance. Three or 4 miles above the mouth of Saginaw River is Bay City, which, since 1860, when it had but 700 inhabitants, has developed into the third city of Michigan with a population of about 25,000. It has a river frontage of 5 miles, and vessels of the largest size can load and discharge at its docks. Several railways afford full communication with all parts of the country, and a number of lines of river and lake steamers furnish the same facilities for travel and traffic by water. Opposite Bay City is West Bay City, a town of 10,000 inhabitants.

Historical notes.—The first fishing in the vicinity was with pound-nets and seines in 1860, and the average size of the fish caught was greater then than in 1885. The first dealer in fish began operations in 1868.

Pound-net fishery.—Bay City and West Bay City form the center of the extensive pound-net fishery of Saginaw Bay. There are several small steamers used in this business at Bay City, where there are a number of fish dealers. These firms with another at West Bay City do a very large business, buying millions of pounds of fish every year, principally pickerel, bass, trout, sturgeon, and perch. There are also a good many herring and a few whitefish handled. These fish are caught almost exclusively with the pound-net. Along the bay shores, from Gravelly Point on the west side to Oak Point on the other, are great numbers of pounds. They are nearly always set in water from 7 to 20 feet deep, the few exceptions having in no instance a greater depth than 30 feet. There are nearly one hundred and twenty-five pound-nets in the Saginaw River of similar depth.

Gill-net fishery.—There are a few gangs of gill-nets owned at Bay City, and there is a single gill-net crew at Port Austin, near Point aux Barques, the eastern limit of Saginaw Bay. Port Austin, which is a town of about 900 inhabitants, has had fisheries of varying importance since 1840. Gill-nets were used here at that date, and between 1850 and 1860 the number of gill-net crews reached a dozen or fifteen. In those days whitefish was the principal species taken, but in the few

nets now used, which have smaller meshes and finer twine than formerly, the catch is chiefly trout, and scarcely any whitefish are taken, while their size has much decreased.

Fyke-net fishery.—The fyke-net fishery, which is of considerable importance, is usually carried on by men who also have pound-nets. There are, altogether, about seventy-five fykes fished in different portions of Saginaw Bay, and in the river and its tributaries there are considerably over four hundred, of which nearly half are fished above Saginaw City.

Ice fishing.—Formerly the winter fishing through the ice was very important. In January, 1875, between three and four hundred shanties, 6 by 12 feet in size, built of rough boards covered with building paper, were located upon the ice at the mouth of the Saginaw River. In each of these, beside a small sheet-iron stove, crouched a fisherman, armed with a short-handled spear, who all day long watched over a hole about 18 inches square, through which he dangled with his left hand some fresh herring, tied to a string, holding ready the spear in his right hand. The fish thus decoyed within his reach he skillfully transfixed by a sudden dart of the spear, and hauled it in by means of a line fastened to it. The shanties were placed over water from 10 to 15 feet deep, through which the sandy bottom of the lake, together with every intervening object, was plainly visible to the fisherman peering through the hole. In the winter of 1874–'75 the value of the fish caught in this way was about $40,000 a month. In 1878 the hook-and-line was generally adopted by the winter fishermen, with minnows for bait, and was found to be easier and more successful than the other method. At present both spears, lines, and herring gill-nets are used in winter, but the fishery at this season is no longer important, and the number of men engaged is seldom twenty-five.

Trade.—A very large proportion of the fish caught are shipped fresh. Two of the dealers have establishments for freezing fish; the dealers also salt certain species purchased fresh from the fishermen. The extent of the trade in 1885 is shown in the following table, which represents not only fish taken by Saginaw Bay and River fishermen, but also the catch of other localities in Lake Huron visited by steamers which collect for the dealers:

Species.	Pounds of fish handled.	Average price paid to fishermen.	Pounds frozen.	Pounds salted.
		Cents.		
Whitefish	161,200	4	40,000	69,200
Trout	1,181,550	4	20,000	200,800
Pike and pickerel	1,225,250	4		
Bass	174,500	4		
Herring	1,683,000	1	28,000	970,000
Sturgeon	174,000	2		
Bull heads	48,500	2		
Perch, mullet, suckers, etc	1,705,000	1½		62,000
Total	6,353,000		88,000	1,302,000

Statistics.—The total number of men engaged in the fisheries in 1885 was 565, of whom 543 were fishermen and 22 were preparators. These operated 440 pound-nets, valued at $71,925; 335 gill-nets, valued at $3,010; 499 fyke-nets, valued at $22,910; and minor apparatus and accessories, valued at $9,450. They used 4 steamers, worth $13,300, and 385 gill-net, collecting, pound-net, and other boats, worth $16,090. The value of the shore property, including 105 fish-cars, was $32,434. The amount of the working capital was $26,000.

The fisheries of Saginaw Bay and River are the most important in Lake Huron, and the catch is far in excess of that of the two next important sections, namely, Alpena County and the north shore. The yield in 1885 consisted of 7,580,150 pounds, and was valued at $153,079. The quantities of the principal species were 168,500 pounds of whitefish, 589,000 pounds of trout, 673,000 pounds of pike and pickerel, 1,020,350 pounds of herring, 152,500 pounds of bass, 808,160 pounds of bull-heads, 80,640 pounds of sturgeon, and 4,088,000 pounds of perch, suckers, mullet, and other minor varieties. The entire catch was sold fresh, the main portion going to dealers, who froze and salted considerable quantities.

80. LOWER LAKE HURON (HURON, SANILAC, AND ST. CLAIR COUNTIES), MICHIGAN.

Review of coast towns.—Below the entrance of Saginaw Bay the coast line runs south by east for about 70 miles, from Pointe aux Barques to Fort Gratiot, at the entrance of St. Clair River. Among the numerous villages on this shore there are ten in which there is record of the past or present existence of small fisheries. These are Grindstone City, Huron, Port Hope, Sand Beach, White Rock, Forestville, Forester, Port Sanilac, Lexington, and Lake Port, all small places with populations of from 100 to 1,500. At Sand Beach a government breakwater 2 miles long assists in rendering it one of the best ports on the lakes.

Historical notes on the fisheries.—In 1850 fishing began about a mile north of Forester with gill-nets and a seine, and soon seines, lines, or the large-meshed, coarse-twined, float-and-stone gill-nets of that time were in use at most of the coast settlements, though it was as recently as 1872 that fishing was first prosecuted at Grindstone City. Whitefish were then the most common species, and were obtained in abundance, 300 pounds to each net being frequently taken, while single catches several times as large were often made. Forestville formerly had a much more important fishery, and the same is true of Lexington, where the business reached its height between 1867 and 1870. The gill-net fishery of Port Hope was formerly of some importance, but it was not prosecuted in 1885. The fishing which was once carried on in a small way at Huron and White Rock entirely ceased in 1882.

Present condition of the fisheries.—At the present time gill-nets are employed at Grindstone City, Forestville, Forester, and Lexington,

which places have one crew each, and at Sand Beach and Port Sanilac, where there are two and three crews, respectively.

Only nine pound-nets were fished in 1885. Four of these were owned and operated at Forester, where they were introduced in 1883; one was set at Lexington, and four, owned by Detroit parties, were located on the shore south of Lake Port.

The gill-nets now used are from 130 to 580 feet long and 5 feet deep. The largest are at Grindstone and Sand Beach.

At Port Sanilac the season is from the middle of April to the middle of September; the crew at Grindstone City fishes in the spring and fall, laying up for a while in the summer, and that at Forester carries on its operations only in winter. The pound-nets are from 16 to 30 feet deep, and are fished in spring and fall.

The products.—The catch consists principally of trout, except in the vicinity of Forester, where the whitefish is still the most abundant species. Prior to 1875 all were salted; but at that date the practice came into vogue of shipping in a fresh condition.

Statistics.—The total number of men employed in the fisheries along this coast in 1885 was 34; boats, 19, valued at $2,085; pound-nets, 9, valued at $3,300; and gill-nets, 615, valued at $4,318. The minor apparatus and accessories had a value of $830 and the shore property of $1,175. The products in the same year amounted to 188,070 pounds of trout, 50,500 pounds of herring, 17,700 pounds of whitefish, 7,200 pounds of sturgeon, 6,900 pounds of pike and pickerel, and 600 pounds of minor species, the total catch being 270,970 pounds, valued at $8,803. Of the herring, 20,000 pounds were salted, but all the other fish were sold fresh.

VI.—THE FISHERIES OF LAKE ST. CLAIR AND OF THE ST. CLAIR AND DETROIT RIVERS.

81. GENERAL REVIEW.

Method of treatment.—Although not one of the "Great Lakes," it is deemed advisable, on account of the isolated position of Lake St. Clair, to treat of it separately, together with its two rivers, rather than regard it as an adjunct of either Lake Huron or Lake Erie.

Physical character of Lake St. Clair.—The lake is 30 miles long and 24 miles wide at its broadest part, the mean width being about 12 miles; it thus has an area of 360 square miles. The average depth is 20 feet. The flats in the northern part are traversed by a very deep canal lined with dikes, the work of the national government.

Fisheries of Lake St. Clair.—The fisheries are carried on with pound-nets, fyke nets, haul-seines, and set-lines. The total output is larger than that of either the St. Clair River or Detroit River, the great bulk of the catch being herring, perch, and suckers.

Description of the St. Clair River.—The St. Clair River connects Lakes Huron and St. Clair and forms a portion of the boundary line between the state of Michigan and the province of Ontario. It pursues a nearly straight course north and south throughout the 44 miles of its length. The average width is about a mile, and its waters are deep enough to permit the passage of the large steamers which ply on the lakes.

The largest town on the river is Port Huron, a fish market of considerable importance, to which much of the catch of the river and neighboring lake shores is sent.

Fisheries of the St. Clair River.—The fisheries of the river are of remote origin, but have never been so extensively prosecuted as the facilities would warrant. A few gill-nets are now fished, but the bulk of the catch is taken with haul-seines. The yield consists largely of herring, pike, and pickerel, herring being particularly abundant. Whitefish are very scarce; the catch of this species is much smaller than in either the lake or the Detroit River.

Physical characteristics of the Detroit River.—This is a broad stream, 25 miles in length, by means of which the overflow waters of the upper members of the great lake system find their way from Lake St. Clair to Lake Erie. It flows southward, forming a portion of the international boundary. Numerous islands occur in its course, of which Grosse Isle, a short distance above its mouth, is much the largest. Twenty

miles below Detroit, which is situated near the upper part of the river, it expands into a broad estuary and mingles with the waters of Lake Erie.

Fishery interests of the Detroit River.—The fisheries are carried on with pound-nets and set-lines, no other form of apparatus being used. The fish taken are largely herring and whitefish; the catch of the latter is much greater than that of the St. Clair River and Lake St. Clair combined. Very large quantities of fresh, frozen, salted, and smoked fish find their way to Detroit, the extent of whose fish trade is such as to place it in the front rank of the fish markets in the country.

Statistics.—The extent of the fisheries of this region and of the fish-trade of Detroit and Port Huron is shown in the accompanying tables:

Table of persons employed in the fisheries of St. Clair River, Lake St. Clair, and Detroit River in 1885.

Section.	Fishermen.		Preparators and mechanics.	Total persons employed.	Number of persons dependent.
	Professional.	Semi-professional.			
St. Clair River	43	7	3	53	98
Lake St. Clair	81	18	....	99	238
Detroit River	66	....	54	120	180
Total	190	25	57	272	516

Table of apparatus and capital employed in the fisheries of the St. Clair River, Lake St. Clair, and Detroit River in 1885.

Section.	Vessels and boats.					
	Steamers.				Small boats.	
	Fishing.		Collecting.			
	No.	Value.	No.	Value.	No.	Value.
St. Clair River	.....	....	.....	....	29	$803
Lake St. Clair	.....	....	.....	....	162	3,884
Detroit River	1	$400	1	$750	22	1,620
Total	1	400	1	750	213	6,307

Section.	Apparatus of capture.														
	Gill-nets.			Pound-nets.		Fyke-nets.		Seines.			Set-lines.			Value of minor apparatus.
	No.	Length.	Value.	No.	Value.	No.	Value.	No.	Length.	Value.	Length.	No. of hooks.	Value.	
		Feet							*Feet.*		*Feet.*			
St. Clair River	23	9,400	$160	5	$1,200	57	$546	11	4,190	$1,900	45,900	5,100	$75	....
Lake St. Clair	...	....	.....	41	6,950	196	3,044	6	3,490	1,050	24,300	2,700	26	$128
Detroit River	...	....	.....	11	4,400	....	......	17	5,540	5,875	....	......	....	....
Total	23	9,400	160	57	12,550	253	3,590	34	13,220	8,825	70,200	7,800	101	128

Table of apparatus and capital employed in the fisheries of St. Clair River, Lake St. Clair, and Detroit River in 1885—Continued.

Section.	Shore property.					Total capital invested.
	Value of buildings and wharves.	Value of accessories and fixtures.	Fish-cars.		Cash capital.	
			No.	Value.		
St. Clair River	$3, 850	$1, 350	9	$270	$4, 000	$14, 154
Lake St. Clair	1, 800	1, 125	......	....	....	18, 007
Detroit River	93, 950	8, 175	450	11, 250	92, 500	218, 920
Total	99, 600	10, 650	459	11, 520	96, 500	251, 081

Products of the fisheries of St. Clair River, Lake St. Clair, and Detroit River in 1885.

Section.	White-fish.	Pickerel.	Sturgeon.	Herring.	Perch, suckers, etc.	Total.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
St. Clair River	1, 000	158, 990	66, 920	508, 200	34, 900	770, 010	$11, 160
Lake St. Clair	9, 250	68, 650	157, 600	468, 250	438, 960	1, 142, 710	20, 509
Detroit River *	30, 875	2, 940	3, 260	231, 700	4, 300	273, 075	8, 524
Total	41, 125	230, 580	227, 780	1, 208, 150	478, 160	2, 185, 795	40, 193

* The following secondary products, valued at $7,584, should be accredited to the Detroit River: 53,690 pounds of caviare, 1,550 pounds of isinglass, and 800 gallons of oil.

Wholesale fish trade of Detroit and Port Huron in 1885.

Species.	Sold fresh.	Frozen before shipment.	Salted.	Smoked.	Total.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Whitefish	66, 300	16, 000	765, 000	....	847, 300	$50, 335
Trout	2, 834, 470	477, 300	1, 995, 000	....	5, 306, 770	274, 885
Pike and pickerel	1, 417, 230	238, 700	578, 000	....	2, 223, 930	116, 471
Herring	50, 000	324, 000	2, 111, 500	340, 000	2, 825, 500	92, 586
Sturgeon	482, 320	450, 000	....	245, 000	1, 177, 320	70, 793
Catfish	20, 400	....	....	....	20, 400	1, 020
Perch, suckers, etc	350, 000	....	....	....	350, 000	3, 500
Total	5, 220, 720	1, 506, 000	5, 449, 500	585, 000	*12, 761, 220	609, 590

* Of this amount 526,000 pounds were handled at Port Huron.

82. THE ST. CLAIR RIVER, ST. CLAIR COUNTY, MICHIGAN.

Review of towns.—Near the head of the St. Clair River is Port Huron, the most important of the numerous towns along its banks. It was settled at the beginning of the present century and now has a population of about 11,000.

About 12 miles south of Port Huron is the town of St. Clair, settled in 1828 and now having 2,500 inhabitants.

And 8 miles further south is Marine City, with a population of 2,000. Algonac, the same distance below Marine City, was settled in 1832, and now has 1,000 inhabitants.

Extent and character of the fisheries.—Fisheries have been carried on at these places for many years, but only to a small extent. It is said

that seines were used on the site of Marine City in 1812. In 1830 they were used at St. Clair, and in 1832 at Port Huron. In 1885 there were at Port Huron five seines, five pound-nets, and two gill-net crews; at St. Clair, one seine; at Robert's Landing, two seines; at Algonac, one seine, fifty-seven fykes, and forty-six set-lines. The seines are from 330 to 825 feet long and 12 to 20 feet deep. Some are used throughout the season of open water, others only in the spring and fall. The pound-nets are set in water from 20 to 28 feet deep. One of them is fished both in spring and fall, the others in fall only. The gill-nets, which are set only in spring, are from about 250 to 500 feet long and 5 feet deep. The fykes are operated throughout the season of open water. Set-lines are fished only during the month of June. They usually have a hundred hooks each, but sometimes there is a greater number.

Products and trade.—Scarcely any whitefish are taken; pickerel, sturgeon, and herring compose the principal part of the catch. Fish to the amount of over 500,000 pounds are handled annually at Port Huron. Most of the catch is sold fresh, but a large part of the herring and some of the other fish are salted, while about 8 tons of whitefish, 12 tons of herring, and 2 tons of other fish are frozen.

Statistics.—The total number of fishermen in 1885 was 53; the number of boats, 29, worth $803, and the total value of the apparatus of capture detailed above was $4,151. The accessories and minor apparatus were worth $1,350, and the shore property $3,850, the cash capital being $4,000.

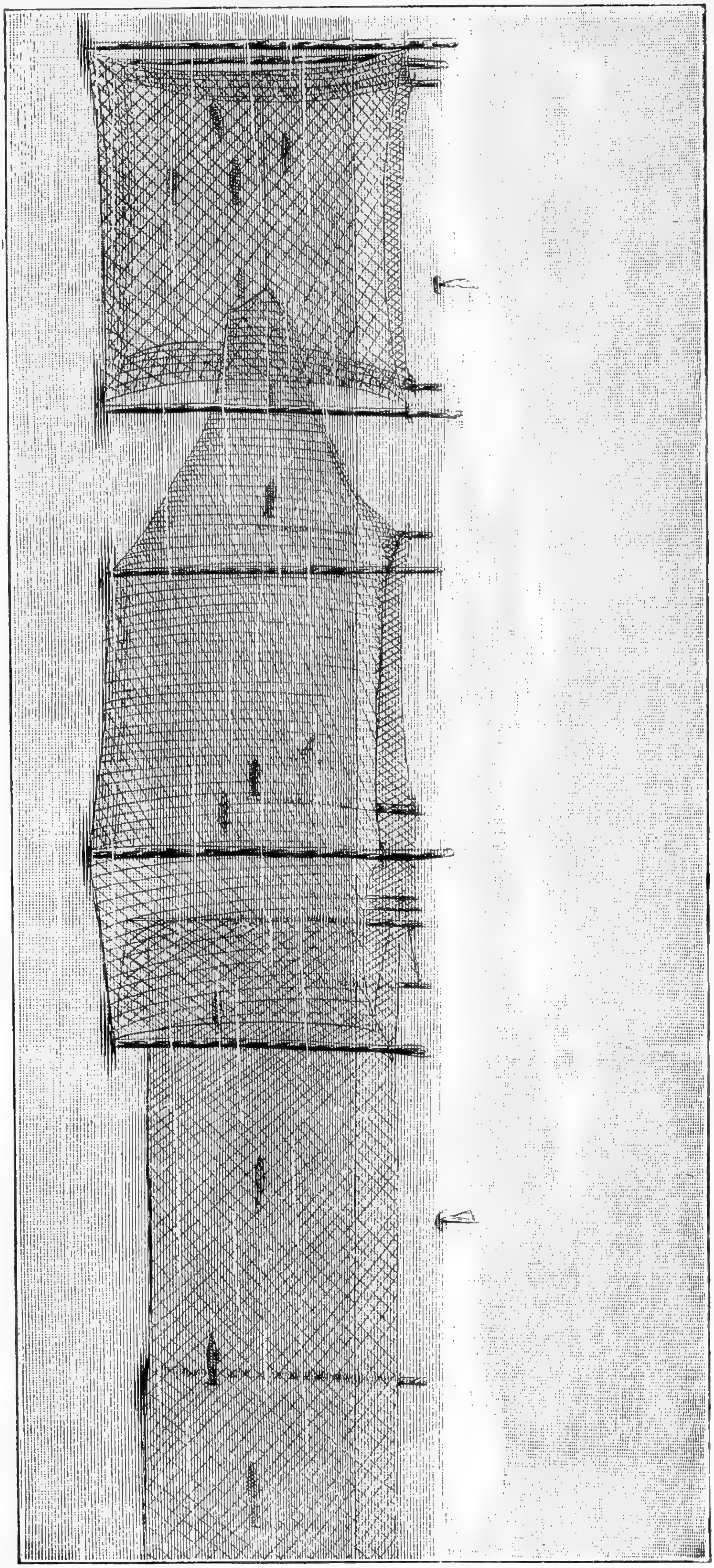
The products were 508,200 pounds of herring, 158,990 pounds of pickerel, 66,920 pounds of sturgeon, 34,900 pounds of perch and minor species, and 1,000 pounds of whitefish, the whole having a value of $11,160.

83. LAKE ST. CLAIR (ST. CLAIR, MACOMB, AND WAYNE COUNTIES), MICHIGAN.

Fishery centers.—The towns on the lake from which fishing is followed are New Baltimore and Mount Clemens. The first named is situated on the northern arm of the lake called Anchor Bay, and has a population of 1,000. Mount Clemens is on the Clinton River, 10 miles southwest of New Baltimore, and has a resident population of about 4,000.

Fisheries of New Baltimore.—The fisheries of New Baltimore are of some importance. Seines were introduced about 1855, and pound-nets in 1874. In 1885, eight pound-nets, one seine, and seventy-four fykes were fished, besides a trammel-net and a few set-lines. The use of seines is at present greatly restricted by the game clubs which control the seining-grounds in the northwestern part of Anchor Bay and between the Bay and the St. Clair River.

Fisheries of Mount Clemens.—At Mount Clemens three seines and twelve fyke-nets are used. In the marshes between the Clinton and Milk



POUND-NET IN THE DETROIT RIVER.

Sketch by L. Kumlien.

Rivers there are about fifty fishermen, of French descent, each of whom lives throughout the year, with his family, upon a small scow, making his living by fishing, principally for perch and sunfish, and by the capture of musk-rats. They own, on an average, two fyke-nets apiece, and also do considerable spearing and hook-and-line fishing; their stock amounting to about $150 each annually. South of the Milk River, between that stream and Grosse Point, there are twenty-two pound-nets set, with from one to six in a string; and there is a single seine operated at Grosse Point, near the head of the Detroit River.

The seines used differ greatly in size. The greatest length is 1,023 feet, the least is about 188 feet, while the average would be about 600 feet. The depth varies from 8 to 25 feet, averaging about 13 feet. The fishing season for two of the seines in the vicinity of New Baltimore is in the fall and winter, and that for the seine at Grosse Point is in the latter part of May and during the month of October; for all others it is confined to two months in the spring. The pound-nets are 6 to 20 feet deep, and are fished during the months of May, June, October, and November. The set-line season is in July, August, and September. Fykes are fished throughout the year.

Products and trade.—The principal species caught are herring, perch, sturgeon, and pickerel. No whitefish are taken north of Milk River. The fish are shipped fresh to Detroit; in the summer they go by water in barrels packed with ice; in the winter they are hauled by teams.

Statistics.—The number of fishermen in 1885 was 99, of whom 81 were professionals and 18 semi-professionals. They used 162 boats valued at $3,884; 41 pound-nets valued at $6,950; 6 seines valued at $1,050; 196 fyke nets valued at $3,044; 21,600 feet of set-lines, with 2,700 hooks, valued at $26; other apparatus, including 1 trammel-net and 40 spears, valued at $1,253, and wharves and buildings valued at $1,800.

The catch amounted to 1,142,710 pounds, and was valued at $20,509. The herring and perch constituted nearly three-fourths of the catch, namely, 907,210 pounds, the quantities of the other species being 157,600 pounds of sturgeon, 68,650 pounds of pickerel, and 9,250 pounds of whitefish.

84. THE DETROIT RIVER, WAYNE COUNTY, MICHIGAN.

The town of Ecorse.—In addition to Detroit, there are many other smaller towns on the shores of this river of which the only one interested in fishing is Ecorse, 10 miles south of Detroit. This place was settled in 1840, and now has about 400 inhabitants, principally dependent upon the lumber mills and brick burning. Seine-fishing was introduced on the site of Ecorse before 1830.

The fisheries of Detroit and Ecorse.—There are several firms at Detroit by whom fisheries are operated, on a large scale, in all parts of the lakes; but the fisheries in the vicinity of the city itself are of comparatively small importance. Eleven pound-nets and eleven seines,

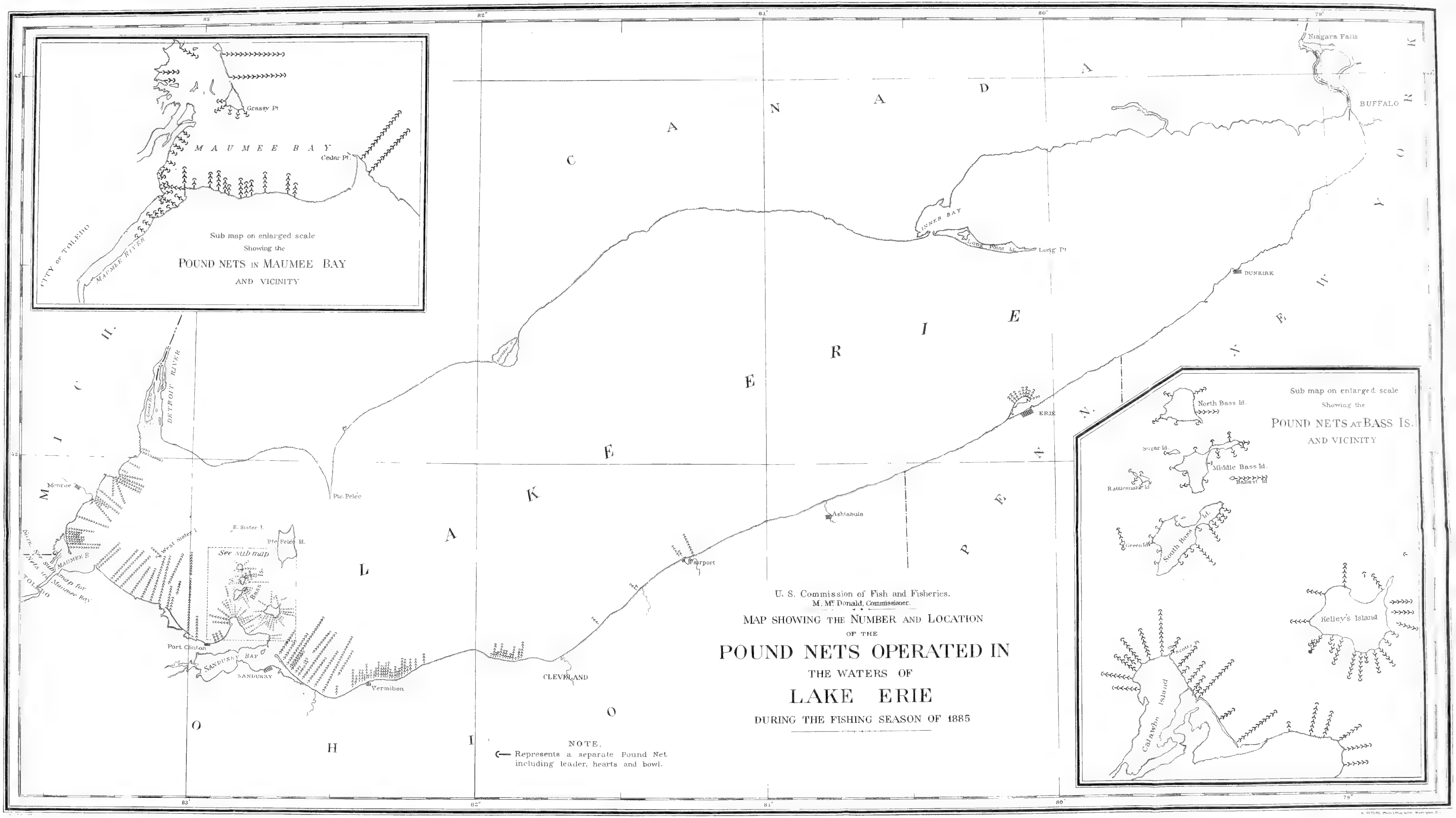
owned at Detroit, are fished at different places in the river or near its mouth; and six seines owned at Ecorse are hauled on the shores of several of the lower islands. One of the firms at Ecorse uses a small steamer in its fishery.

Apparatus and fishing season.—The pound-nets are from 15 to 35 feet deep, and are kept in the water only during the months of October and November. The seines average a little over 320 feet in length and 32 feet in depth and are usually fished from the middle of September to the middle of November, though in one instance the fishing season includes part of the month of May and in the fall is limited to the month of October. The catch is principally herring and whitefish.

Trade.—There are half a dozen firms who deal very extensively in fishery products, handling 12,199,220 pounds in 1885, valued at $581,490. Three of these firms deal in both fresh and salt fish, and treat large quantities in their freezers; one of them also prepares caviare, oil, and isinglass quite extensively; two of the others are engaged exclusively in freezing and smoking herring and sturgeon and manufacturing isinglass and caviare; while the remaining house deals in salt fish only. The fishermen at Ecorse keep their fish in pens until winter, and in this way are able to get the highest market price for them.

Statistics.—One hundred and twenty men were employed on the Detroit River in 1885, in connection with the fisheries, of whom 66 were fishermen, 53 preparators, and 1 a mechanic. The fishermen operated 11 pound-nets, valued at $4,400, and 17 seines, valued at $5,875; using 1 fishing steamer and 1 collecting tug, valued at $1,150, and 22 boats, valued at $1,620. Miscellaneous apparatus and accessories were worth $8,175; wharves, buildings, and other shore property, $93,950; and the working capital amounted to $92,500.

The products in 1885 amounted to 231,700 pounds of herring, 30,875 pounds of whitefish, 4,300 pounds of perch, suckers, etc., 3,260 pounds of sturgeon, and 2, 940 pounds of pickerel, the total catch aggregating 273,075 pounds, valued at $8,524. Secondary products made from the sturgeon were valued at $7,584, and consisted of 53,690 pounds of caviare, 1,550 pounds of isinglass, and 800 gallons of oil.


U. S. Commission of Fish and Fisheries.
M. Mc Donald, Commissioner.
MAP SHOWING THE NUMBER AND LOCATION OF THE
POUND NETS OPERATED IN THE WATERS OF
LAKE ERIE
DURING THE FISHING SEASON OF 1885
NOTE.
Represents a separate Pound Net including leader, hearts and bowl.
Sub map on enlarged scale Showing the
POUND NETS IN MAUMEE BAY AND VICINITY
MAUMEE BAY
Grassy Pt
Cedar Pt.
CITY OF TOLEDO
MAUMEE RIVER
Sub map on enlarged scale Showing the
POUND NETS AT BASS IS. AND VICINITY
North Bass Id.
Sugar Id.
Middle Bass Id.
Rattlesnake Id.
Ballast Id.
Green Id.
South Bass Id.
Kelley's Island
Catawba Island
CANADA
NEW YORK
PENN.
MICH.
OHIO
LAKE ERIE
Niagara Falls
BUFFALO
INNER BAY
Long Point Id.
Long Pt
DUNKIRK
ERIE
Ashtabula
Fairport
CLEVELAND
Vermilion
SANDUSKY
SANDUSKY BAY
Port Clinton
Pte. Pelee
Pte. Pelee Id.
E. Sister I.
West Sister I.
See sub map
Bass Is.
DETROIT RIVER
Monroe
MAUMEE B.
TOLEDO
See sub map for Nets in Maumee Bay
83°
82°
81°
80°
79°
42°
43°

VII.—THE FISHERIES OF LAKE ERIE.

85. GENERAL REVIEW.

Geographical description.—Lake Erie is about 240 miles long and 40 miles wide, the greatest width, opposite Ashtabula, Ohio, being 58 miles. It is much smaller than either Lake Superior, Lake Michigan, or Lake Huron, but is somewhat larger than Lake Ontario. Its area is 9,000 square miles.

This is the shallowest of all the Great Lakes. Its average depth is only 80 feet, while the deepest portions are only 220 feet. The depth varies considerably within certain limits in the different sections. The western end is very shallow, being only from 4 to 7 fathoms deep. Off Lorain, Cuyahoga, Lake, and Ashtabula Counties the water is from 11 to 14 fathoms deep a short distance from the shore. The greatest depth in the lake occurs between Erie, Pennsylvania, and Dunkirk, New York, on the American side; and around Long Point Island on the Canadian shore, where the water ranges from 18 to 35 fathoms. At the eastern end the soundings decrease, and in no place is the depth more than 15 fathoms, while the average depth is not more than 10 or 12 fathoms.

The American shore of the lake is about 414 miles in length; it is formed by the States of Michigan, Ohio, Pennsylvania, and New York. Ohio has 247 miles of coast line, which is the longest of any state, while New York, Pennsylvania, and Michigan have respectively, 75, 47 and 45 miles of shore.

The rivers connected with the lake are of but little importance, if we except the Detroit and Niagara Rivers. The others—the Maumee, Sandusky, Cuyahoga, and Chagrin—are small and have little commercial value except at their mouths.

But few large islands occur and these are all in the western portion. They are the Bass Islands, three in number, Kelly's Island, and Pointe Pelée Island; the last is in Canada, but the others belong to the state of Ohio.

Important cities and towns are located on Lake Erie that are referred to in detail in the following pages and need only be named at this point. They are among the principal cities of the United States, and include Toledo, Sandusky, Cleveland, Erie, Dunkirk, and Buffalo.

Importance of the fisheries.—The fisheries of the lake are of vast importance, surpassing in extent those of any other of the Great Lakes or of any other body of fresh water in the world.

Among the causes and conditions which have operated to promote the fishery interests of the lake and to give them the importance which they have attained, may be mentioned the early settlement of the lake region, and the consequent early inauguration of fishing as an easy and at that time probably necessary method for obtaining food.

Aside from artificial propagation, which has had a marked influence on the development and perpetuation of the fisheries in this as in other lakes, the natural conditions appear to have been potent in maintaining them. The shallowness of a large portion of the lake has made it possible to set certain kinds of apparatus in greater quantities and over larger areas than would otherwise be practicable. Extermination of the most valuable species would, however, soon be accomplished were it not for the existence of vast spawning grounds in the region of the most extensive fishing operations, namely, in the vicinity of the islands in the western end of the lake, and the fact that the existence of these has made it possible, in recent years, to carry on artificial propagation in that locality upon a scale which is sufficient to prevent the depletion that otherwise would occur.

Many who are conversant with the subject believe that the growth of the fisheries of the western portion of the lake, at least, is due largely to the fact that the state laws do not unnecessarily embarrass or restrict the fishermen in their work.

Pound-net fishery.—This is the most extensive fishery in the lake. The first nets were set in Maumee and Sandusky Bays about 1850, but pounds did not come into general use till between 1860 and 1870, when they were rapidly introduced along the shores west of Huron, Ohio. In the eastern portion of the lake pound-nets came but recently into use, but they are becoming the paramount form of apparatus in many communities, and the number set will probably be largely augmented in a few years, to the promotion of the fishery interests of the region.

The pound-net fishery of Lake Erie is at the present time practically confined to that portion of the lake west of Cleveland. East of that city the nets are scattered and comparatively few in number, there being but seven between Cleveland and Fairport, fourteen at Fairport, and nineteen at Erie, while west of Cleveland there are no less than eight hundred and eighty-eight pounds, which are located at very short distances and in longer or shorter strings along the entire coast-line from Cleveland to the mouth of the Detroit River.

Owing to the shallowness of the water in the western end of the lake, pound-nets can be set at long distances from the shore. There is no reason, indeed, why they could not be continued in an unbroken line entirely across the lake. The longest strings of nets occur between Vermillion and Sandusky, also west of Port Clinton and between it and Maumee Bay. In the former locality are three strings, containing twenty, twenty-one, and twenty-two pounds, respectively, and several

others only slightly shorter. Near Port Clinton are thirty nets in a single string, which extend in a northerly direction east of West Sister Island a distance of 10 miles from the shore. Other stands of considerable length, some containing seventeen nets, occur near by.

Seine fishery.—This began in Maumee River about seventy years ago, when fish were abundant, but facilities for getting the catch to market were very meager. Seines were first used in the lake, off Cedar Point, in 1854. With increased advantages for transportation, the fishery became important and reached its highest development during the decade following 1850, when between five hundred and six hundred men were engaged in seine fishing between Cedar Point and Locust Point. The pound-net has gradually superseded the seine on the lake, where the seine fishery now amounts to almost nothing. On the Maumee River, however, seines are still extensively used, no less than two hundred and thirty people following the fishery in 1885. Seines are also employed to a small extent in Monroe County, Michigan, at Erie, Buffalo, Irving, Sandusky, and on the Bass Islands.

Gill-net fishery.—Gill-nets for whitefish, trout, herring, sturgeon, pike, and pickerel, saugers, etc., are fished throughout the lake, except in the extreme western part. They are most numerous at Erie and Sandusky, where over sixteen thousand nets were operated in 1885.

Three forms of nets are in use, one of which, the float-and-stone variety, which was the earliest kind employed, is rapidly being supplanted by more modern rigged nets, with corks and rings or corks and leads.

In the early history of the fishery small open boats were used from which to operate the nets; these were necessarily dangerous, slow-moving, and therefore wholly inadequate; their employment did much to retard the development of the fishery on the off-shore grounds where it was likely to be most profitable. Within the past few years, however, one dealer after another has provided himself with one or more fishing-steamers with such an entirely satisfactory result that more vessels of this class are being built each year, and the gill-net fishery is correspondingly increasing. In 1885 there were forty-three steamers used in the fisheries of Lake Erie, of which thirteen were employed simply in collecting fish, while the others were fitted with fishing apparatus.

Fyke-net fishery.—Fyke-nets are more numerous in Lake Erie than in any of the other lakes, and the output of the fishery is very large and valuable. The shallow waters at the western end of the lake, especially those of Sandusky Bay and vicinity, are well suited to this kind of apparatus, and in the particular locality just named nearly a thousand fykes and miniature pounds were set in 1885.

Set-line, ice, and other fisheries.—Set-lines are extensively fished in all portions of the lake. The total length of the lines in 1885 was over 940 miles. The species taken are chiefly catfish in the western part of the lake, while at Buffalo sturgeon, pike, perch, herring, whitefish, and mullet are caught.

Ice fishing, with lines, is prosecuted at various places on the lake, but particularly at Cleveland and Buffalo, the fishery in the latter city being very important. Gill-netting under the ice is not followed to the extent to which it is in some of the other lakes.

Winter spearing, for pickerel, is engaged in only to a limited extent, as is also the use of grapnel-hooks for sturgeon. Angling is participated in by thousands of people who are attracted, sometimes from distant places, by the fine facilities for pleasure fishing afforded by the lake.

Species that are objects of fisheries.—Herring (*Coregonus artedi*) is the most abundant fish occurring in Lake Erie, the catch amounting to over 19,000,000 pounds, or more than one-third of the total yield for the lake. The fishermen of Sandusky and vicinity alone took over 8,000,000 pounds, and large quantities were also secured at Erie, Cleveland, and Huron, and everywhere in the western end of the lake. East of Erie, however, very few occur.

Next to herring, "blue pike" (*Stizostedium vitreum* var. *salmoneum*) is the most abundant species, particularly large numbers being taken at Erie, Cleveland, and Buffalo, the total catch amounting to nearly 8,000,000 pounds.

Saugers (*Stizostedium canadense*) occur plentifully in the western end, the catch east of Cleveland being light and confined chiefly to Buffalo.

As regards the actual number of pounds taken, sturgeon (*Acipenser rubicundus*) rank fourth, but of course the number of individual fish is much less than any other important species. The most extensive fishery for sturgeon is at Buffalo. Considerable quantities occur throughout the lake, except in Chautauqua County, New York, west of Irving, and in Maumee Bay and River, where the catch is small.

Nearly two-thirds of the whitefish (*Coregonus clupeiformis*) taken in Lake Erie are caught by the fishermen of Erie, Pennsylvania, who handled over 2,000,000 pounds of the total yield of 3,500,000. The species, although less common than in either Lake Superior or Lake Michigan, can not be considered scarce in any section of the lake except in that portion east of Erie.

Catfish and bull-heads (*Amiurus*) rank next to whitefish and occur in greatest numbers west of Erie, the largest catches being in the vicinity of Sandusky and westward to the end of the lake. The yield in Lake and Ashtabula Counties, Ohio, is also considerable.

Wall-eyed pike (*Stizostedium vitreum*) is the only species except sturgeon which is taken in greater quantities in the eastern end of the lake than in any one locality in the western portion. At Buffalo the fish is very abundant and about one-third of the entire catch of the lake is taken there.

Perch (*Perca americana*) may next be mentioned. From the lower portion of the lake but comparatively few are secured, but at Erie, Cleveland, Sandusky, Toledo, and other places the species is abundant.

Ranking next in commercial importance come bass (*Micropterus salmoides* and *M. dolomiei*), which are found over the entire lake. Two-thirds of the yield is in the vicinity of Sandusky.

"Grass pike" (*Esox lucius*) and muscallonge (*E. nobilior*) occur, but only west of Erie, while trout (*Salvelinus namaycush*), which are not at all abundant in this lake, are found only east of that city. Suckers, mullet, and other minor species complete the list. These occur everywhere, but are taken in largest quantities at Sandusky and Erie.

The trade.—The fish trade of Lake Erie is enormous, surpassing that of any other lake. The sales of fish and other fishery products by wholesale firms—numbering about fifty—amounted to nearly $2,000,000 in 1885.

In certain fishing centers much of the apparatus is owned and operated by the dealers, this being noticeably the case at Sandusky, Huron, Vermillion, and Erie, in all but the first named of which places the pound-nets are entirely controlled by dealers. When not having apparatus of their own, dealers usually buy from independent fishermen to whom material and supplies are advanced.

The principal communities as regards the extent of their fisheries are also the chief markets. Sandusky ranks first among the markets of the Great Lakes as it does among the markets of the world for fresh-water fish. Next to Sandusky come Erie, Buffalo, Cleveland, Toledo, Port Clinton, and Huron, in the order named. Detroit also receives a fair proportion of the fish taken in Monroe County and the western end of the lake. At Sandusky, Cleveland, and Buffalo large quantities of Canadian fish are marketed, these being included with the other fish in the statistical summary of the wholesale fish trade which follows.

The fish generally reach the hands of the wholesale dealers in a fresh state and a considerable proportion are then frozen, salted, or smoked before shipment. The dealers in all the principal localities have freezers in which fish may be preserved for an almost unlimited time if necessary. Over 7,000,000 pounds were thus treated in 1885. Fish are salted in Ohio and Pennsylvania, but not in the other states bordering on this lake. About 10,000,000 pounds were salted in 1885, of which three-fifths was the output of Sandusky. Smoking is practically confined to Sandusky, Erie, Cleveland, and Toledo, where 2,830,000 pounds of fish were thus prepared in 1885; 98,000 pounds were also smoked at Buffalo and Fairport, Ohio. The canning of herring is engaged in by a firm at Cleveland; the fish are artificially stained and put on the market as canned salmon.

Regarding secondary products it may be stated that caviare is manufactured in large quantities at Sandusky, Toledo, and Erie, and to a less extent in other places. The local demand is light but increasing. The great bulk of the product is shipped abroad, chiefly to Germany and other European countries. The price at first hands is 10 cents a pound. Isinglass, made from the swimming-bladders of the sturgeon, is manu-

factured chiefly at Sandusky and Toledo. It sells for about $1.50 a pound. Oil completes the list of secondary products of the sturgeon. It is made at Sandusky, Port Clinton, Toledo, and Irving, and brings 40 cents a gallon to the maker.

Statistical summary.—The following tables show in detail, by localities, the extent of the fisheries of Lake Erie in 1885, and are preliminary to a discussion of the fisheries of the different sections.

Table of persons employed in the fisheries of Lake Erie in 1885.

Section.	Fishermen.		Shoresmen and preparators.	Total number of persons employed.	Number dependent on these.
	Professional.	Semi-professional.			
Monroe County, Michigan	214	10	32	256	721
Maumee Bay and River (Toledo, Ohio)	429	80	59	568	1,358
Locust Point to Port Clinton, Ohio	132	12	33	177	416
Sandusky and vicinity, including Bass Islands	590	10	232	832	2,130
Huron, Erie County, Ohio	62	3	70	135	255
Vermillion, Erie County, Ohio	61	....	15	76	160
Lorain and Cuyahoga Counties, Ohio	137	45	68	250	408
Lake and Ashtabula Counties, Ohio	102	32	31	165	350
Erie County, Pennsylvania	225	33	52	310	600
Chautauqua County, New York, west of Dunkirk	9	10	....	19	60
Dunkirk, New York, and vicinity	7	252	....	259	350
Irving, Chautauqua County, New York	9	29	1	39	90
Buffalo and Erie County, New York	....	1,183	29	1,212	1,800
Total	1,977	1,699	*622	4,298	8,698

* Of this number, 524 are employed by the firms who buy the fish directly from the fishermen.

Table of apparatus and capital employed in the fisheries of Lake Erie in 1885.

Section.	Vessels and boats.																	
	Steamers.				Gill-net boats.		Pound-net boats.		Sail-boats collecting fish.		Seine-boats.		Scows.		Small row-boats.		Total.	
	Fishing.		Collecting fish.															
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Monroe County, Michigan	......	......	1	$9,000	......	......	38	$4,475	5	$1,100	4	$850	12	$1,325	74	$900	134	$17,650
Maumee Bay and River (Toledo, Ohio)	......	......	3	16,300	......	......	38	4,275	......	......	42	1,135	10	2,200	189	2,485	282	26,395
Locust Point to Port Clinton, Ohio	1	$500	2	13,000	13	$3,200	5	925	4	1,500	6	120	6	1,375	70	1,445	107	22,065
Sandusky and vicinity, including Bass Islands	8	33,500	2	13,000	42	2,315	122	20,420	7	1,575	4	80	54	15,735	243	5,117	482	91,742
Huron, Erie County, Ohio	......	......	2	2,700	3	450	19	4,525	......	......	......	......	6	2,800	18	395	48	10,870
Vermillion, Erie County, Ohio	3	6,500	......	......	4	320	4	650	......	......	......	......	4	950	30	965	45	9,385
Lorain and Cuyahoga Counties, Ohio	4	15,000	1	10,000	5	650	29	2,900	......	......	......	......	17	2,275	25	500	81	31,325
Lake and Ashtabula Counties, Ohio	7	14,800	......	......	5	1,400	5	1,100	......	......	......	......	1	200	46	1,175	64	18,675
Erie County, Pennsylvania	17	38,900	2	5,000	44	15,800	6	1,200	......	......	1	25	6	4,500	35	815	111	66,240
Chautauqua County, New York, west of Dunkirk	......	......	......	......	5	370	......	......	......	......	......	......	......	......	6	79	11	449
Dunkirk, New York, and vicinity	......	......	......	......	2	350	......	......	......	......	......	......	......	......	7	170	9	520
Irving, Chautauqua County, New York	......	......	......	......	3	280	1	100	......	......	2	125	1	40	22	256	29	801
Buffalo and Erie County, New York	......	......	......	......	2	235	......	......	......	......	3	120	......	......	128	2,285	133	2,640
Total	40	109,200	13	69,000	128	25,370	267	40,570	16	4,175	62	2,455	117	31,400	893	16,587	1,536	298,757

Table of apparatus and capital employed in the fisheries of Lake Erie in 1885—Continued.

Section.	Apparatus of capture.															Shore property.					Total capital invested.
	Nets.				Traps.						Set-lines.			Value of spears hand-lines, and grapple hooks.	Total value of apparatus of capture.	Value of buildings and wharves.	Value of fixtures, and accessories.	Fish-cars.		Cash capital.	
	Gill-nets.		Haul-seines.		Pound-nets.		Fyke-nets.		Other trap-nets.												
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value	Length.	No. of hooks.	Value.					No.	Value.		
											Feet.										
Monroe County, Michigan	......	......	4	$900	204	$41,725	43	$442	......	......	300,000	30,000	$1,000	$60	$44,127	$7,970	$4,000	14	170	$1,000	$74,917
Maumee Bay and River (Toledo, Ohio)	......	......	44	4,860	242	39,290	39	1,710	......	......	1,520,000	151,500	2,030	......	47,890	49,205	8,092	5	100	10,500	142,182
Locust Point to Port Clinton, Ohio	980	$2,088	6	1,200	73	22,475	76	966	......	......	910,000	90,800	1,850	......	28,579	38,795	5,955	27	486	5,000	100,880
Sandusky and vicinity, including Bass Islands	5,395	17,026	5	875	122	20,420	893	57,830	100	7,500	500,000	47,500	715	70	104,436	183,475	32,450	31	768	138,000	550,871
Huron, Erie County, Ohio	180	900	......	......	111	52,125	......	......	......	......	60,000	6,000	90	......	53,115	42,450	6,335	......	......	43,100	155,870
Vermillion, Erie County, Ohio	785	2,020	......	......	23	12,000	......	......	......	......	200,000	20,000	800	......	14,820	8,935	1,410	......	......	4,500	39,050
Lorain and Cuyahoga Counties, Ohio	1,624	4,947	......	......	108	43,250	1	150	......	......	110,000	10,400	375	......	48,722	71,270	12,235	13	325	23,000	186,877
Lake and Ashtabula Counties, Ohio	2,050	10,300	......	......	18	7,800	12	800	......	......	55,000	52,000	1,450	20	20,370	8,200	3,050	......	......	2,000	52,295
Erie County, Pennsylvania	10,700	34,542	1	100	25	10,800	5	250	......	......	250,000	22,500	625	70	46,387	27,100	12,200	5	250	27,000	179,177
Chautauqua County, New York west of Dunkirk	422	1,368	......	......	......	......	......	......	......	......	8,000	800	6	......	1,374	365	152	......	......	......	2,340
Dunkirk, New York, and vicinity	330	1,360	......	......	......	......	......	......	......	......	8,000	800	6	50	1,416	500	206	......	......	......	2,642
Irving, Chautauqua County, New York	95	450	7	200	2	2,400	......	......	......	......	121,000	10,600	80	10	3,140	665	1,858	......	......	300	6,764
Buffalo and Erie County, New York	83	506	4	185	......	......	......	......	......	......	930,000	62,000	625	125	1,441	34,037	1,855	425	6,300	22,000	68,273
Total	22,644	75,507	71	8,320	928	252,285	1,069	62,148	100	7,500	4,972,000	504,900	9,652	405	415,817	472,967	89,798	520	8,399	276,400	1,562,138

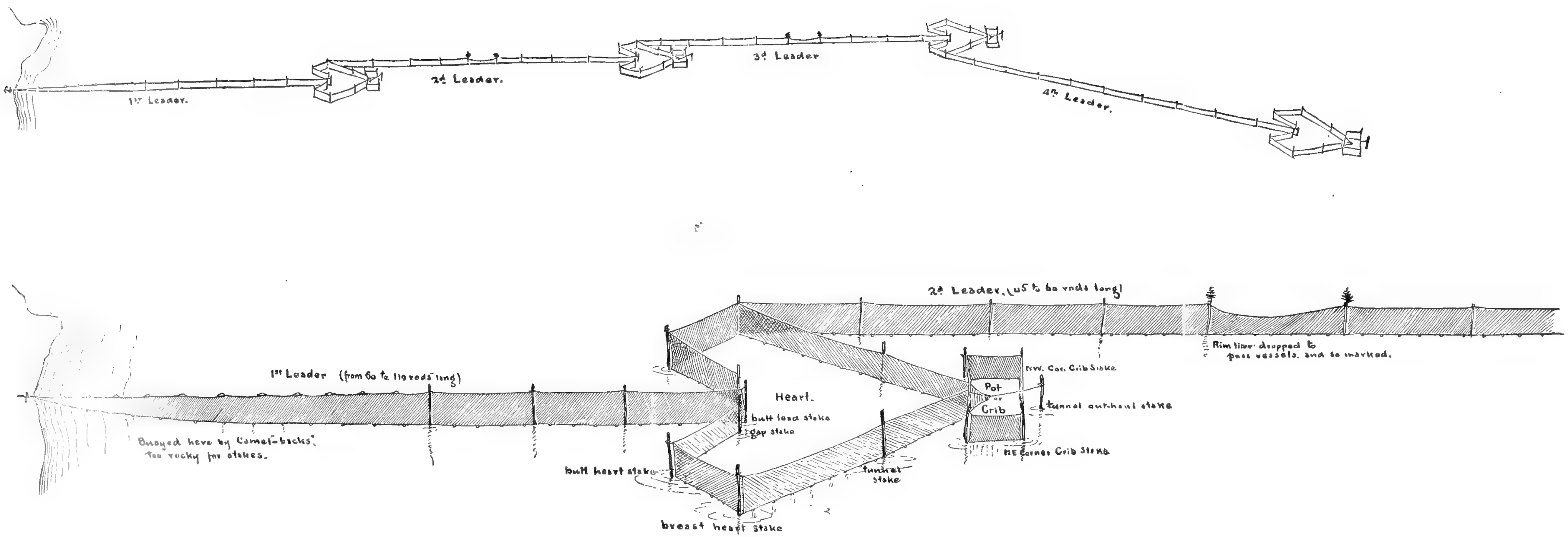
Table of products of the fisheries of Lake Erie in 1885.

Section.	Bass.	Blue pike.	Catfish and bull-heads.	Grass pike and muskel-lunge.	Herring.	Perch.	Saugers.	Sturgeon.	Trout.	Wall-eyed pike.	White-fish.	Suckers, mullet, and other species.	Total.	Value of same to fisher-men.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Monroe County, Michigan	25, 000	10, 000	214, 400	10, 400	837, 200	100, 000	91, 200	91, 300	....	220, 000	133, 400	89, 000	1, 821, 900	$34, 825
Maumee Bay and River (Toledo, Ohio)	70, 000	10, 000	274, 450	13, 400	611, 000	200, 000	1, 232, 200	15, 000	....	625, 300	79, 000	240, 000	3, 400, 350	60, 932
Locust Point to Port Clinton, Ohio	49, 000	20, 000	577, 000	58, 500	995, 000	125, 000	1, 012, 000	36, 000	....	160, 000	146, 500	130, 000	3, 309, 000	52, 500
Sandusky and vicinity, including Bass Islands	450, 000	265, 400	1, 100, 000	155, 000	8, 400, 000	600, 000	2, 155, 000	190, 000	....	508, 500	565, 000	775, 000	15, 163, 900	234, 800
Huron, Erie County, Ohio	10, 400	288, 000	83, 900	16, 140	1, 347, 500	55, 500	287, 100	41, 750	....	17, 500	42, 200	43, 700	2, 233, 690	36, 630
Vermillion, Erie County, Ohio	3, 900	177, 000	51, 000	3, 500	640, 000	30, 000	212, 000	34, 500	....	7, 400	43, 300	23, 000	1, 235, 600	23, 129
Lorain and Cuyahoga Counties, Ohio	10, 000	1, 522, 000	90, 000	12, 000	2, 566, 000	187, 000	353, 000	80, 000	....	70, 000	122, 000	293, 000	5, 305, 000	66, 450
Lake and Ashtabula Counties, Ohio	5, 700	870, 500	275, 500	5, 300	448, 000	68, 000	21, 000	124, 400	....	12, 800	251, 000	44, 000	2, 126, 200	40, 000
Erie County, Pennsylvania	25, 000	3, 570, 000	100, 000	20, 000	3, 397, 000	225, 000	30, 000	392, 000	100, 000	195, 000	2, 119, 500	620, 000	10, 793, 500	240, 000
Chautauqua County, New York, west of Dunkirk	7, 980	18, 700	2, 367	....	59, 000	800	....	....	700	....	2, 900	1, 000	93, 447	2, 397
Dunkirk, New York, and vicinity	10, 500	48, 100	4, 200	....	1, 200	2, 000	....	500	1, 000	25, 000	9, 730	300	102, 530	4, 636
Irving, Chautauqua County, New York	22, 200	8, 000	29, 550	....	11, 000	....	2, 700	62, 500	....	3, 000	4, 150	14, 500	157, 600	7, 055
Buffalo, and Erie County, New York	14, 000	1, 091, 425	....	....	12, 000	8, 000	70, 000	3, 660, 000	5, 200	850, 000	13, 175	....	5, 723, 800	302, 742
Total	703, 680	7, 899, 125	2, 802, 367	294, 240	19, 354, 900	1, 601, 300	5, 466, 200	4, 727, 950	106, 900	2, 694, 500	3, 531, 855	2, 273, 500	51, 456, 517	1, 109, 096

Wholesale fish trade of Lake Erie in 1885.

Section.	No. of firms buying directly from fishermen for wholesale trade.	Fish.										Secondary products.						Total value of fishing products handled.
		Fresh.		Frozen.		Salted.		Canned (estimated).		Smoked.		Caviare.		Oil.		Isinglass.		
		Pounds.		*Pounds.*		*Pounds.*		*Pounds.*		*Pounds.*		*Pounds*		*Galls.*		*Pounds.*		
Monroe County, Michigan	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Maumee Bay and River (Toledo, Ohio)	6	2, 284, 700	$77, 650	772, 000	$31, 680	600, 000	$15, 700	......	......	120, 000	$7, 200	75, 000	$9, 000	500	$200	1, 000	$1, 500	$142, 930
Locust Point to Port Clinton, Ohio	2	2, 675, 280	54, 905	400, 000	20, 100	80, 000	2, 075	......	......	......	......	1, 380	166	2, 500	1, 125	27	38	78, 409
Sandusky and vicinity, including Bass Islands	11	9, 185, 040	192, 080	3, 390, 000	114, 100	5, 926, 000	153, 020	......	......	2, 330, 000	175, 750	156, 575	21, 150	3, 485	1, 325	3, 250	4, 875	662, 300
Huron, Erie County, Ohio	7	1, 080, 600	25, 995	419, 000	13, 480	631, 000	16, 500	......	......	......	......	......	......	......	......	......	......	55, 975
Vermillion, Erie County, Ohio	3	330, 600	9, 454	187, 300	9, 840	230, 000	5, 180	......	......	......	......	......	......	......	......	......	......	24, 474
Lorain and Cuyahoga Counties, Ohio	*11	3, 534, 000	64, 330	761, 000	39, 735	1, 960, 000	42, 550	100, 000	$8, 000	180, 000	10, 000	4, 200	500	......	......	......	......	†165, 115
Lake and Ashtabula Counties, Ohio	3	1, 195, 500	25, 000	145, 000	5, 000	201, 000	6, 000	......	......	18, 000	850	7, 000	840	100	30	300	450	38, 170
Erie County, Pennsylvania	6	9, 140, 000	328, 000	870, 000	55, 000	284, 000	10, 000	......	......	200, 000	10, 000	97, 500	9, 750	......	......	......	......	412, 750
Chautauqua County, New York, west of Dunkirk	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Dunkirk, New York, and vicinity	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Irving, Chautauqua County, New York	1	......	......	......	......	......	......	......	......	......	......	5, 500	550	250	150	200	350	1, 050
Buffalo, and Erie County, New York	3	2, 775, 000	188, 000	535, 000	45, 850	......	......	......	......	80, 000	6, 400	10, 000	1, 000	......	......	......	......	241, 250
Total	53	31, 200, 720	965, 414	7, 479, 300	334, 785	9, 912, 000	251, 025	100, 000	8, 000	2, 928, 000	210, 200	357, 155	42, 956	6, 835	2, 830	4, 777	[illegible]	[illegible]

*Including one caviare-maker and seven smoke-houses.
†To this may be added the value of 250 tons of fertilizer prepared from fish by two small firms not included in first column.



LAKE ERIE POUND-NETS, FOR CAPTURE OF WHITEFISH, HERRING, ETC.

White-oak stakes. 30 to 60 feet long, 6 inches to 1 foot diameter; the leader stakes 5 to 6 feet apart. Rim line to leader and heart just at water surface. Rim line to pot about 2 feet above surface. Bottom line to leader and heart fixed with stone sinkers.

Drawn by H. W. Elliott.

86. MONROE COUNTY, MICHIGAN.

Geographical description.—Monroe County, which occupies the southeast corner of the lower peninsula of Michigan, is washed by the waters of the upper end of Lake Erie along its whole eastern boundary, which is between 40 and 50 miles in length. The coast-line is broadly undulating and occasionally broken, and the neighboring lake bottom is formed of sand, clay, and mud. Monroe, a place of 6,500 inhabitants, is the only city. Besides this there are several villages and small settlements from 1 to 5 miles from the shore and one farming and fishing settlement with no post-office, called Brest, a few miles northeast of Monroe at the mouth of Stony Creek. The population along the shore and for many miles toward the interior consists principally of persons of French descent.

Methods of fishing.—The fisheries, which are of great importance, are operated mostly by Monroe or Toledo capital, and are carried on chiefly with pound-nets, but there is some fishing with set-lines for catfish and turtles in summer, with seines and fykes in late autumn, winter, and early spring, and with spears through the ice for a month or two in winter. The pound-net has been in use here since 1857. The leading fishery operations are conducted by a Toledo firm which has stations at Stony Point, Pointe Manillée, and Monroe, besides its principal one at Brest. Some of the fishermen are residents of Monroe or Toledo and others are scattered along the shore, in some cases having small farms within a convenient distance from the water. Those who live far from their fishing-ground frequently have fishing shanties on the beach. The owners of apparatus commonly hire the fishermen, paying, in 1884, $25 to $30 per month, with board, to the common fishermen, and $40 to $60 per month, with board, to foremen and boat captains. The boats used are occasionally made by the fishermen themselves, but are usually purchased from regular boat-builders at Toledo, Sandusky, and Port Clinton. A few are constructed in Monroe.

Relative abundance of the different species of fish.—Although there are no reefs along this coast, it is claimed by some that the whitefish spawn here to some extent. It is stated, however, by competent authority—one who has had twenty-five years' experience as a fishery operator in this section—that whitefish of less than a pound weight are rarely taken here. The species was formerly very abundant, but has gradually diminished in numbers while at the same time improving materially in size. Where from ten to fifteen years ago between 75 and 100 tons of whitefish were caught in a season with fifteen nets, only 25 or 30 tons are now obtained from sixty nets. The decrease is attributed to the greatly increased number of gill-nets and pound-nets about the islands and in other places, and also to the small mesh of the gill-nets used on the fishing-grounds at the eastern end of the lake. The average size of the whitefish, which was formerly from 2 to 3 pounds, is now

from 3 to 4 pounds, and in the season of 1884 was greater than in any previous year. They are now caught chiefly between the middle of November and the middle of December. While the whitefish have been decreasing in number, and voracious species like lake trout have been almost exterminated, the hardy and prolific herring, thus rid of their worst enemies, have been on the increase, and the catch in 1884 was the largest ever known. At one place where 42,000 pounds were taken in ten pound-nets in 1881, the quantity had risen in 1884 to 134,000 pounds for twelve nets. The average size of herring has meanwhile risen from half a pound to three-quarters of a pound. Sturgeon were originally very abundant, but for many years only a few were made use of and the remainder were thrown away.

Trade.—About three-quarters of the fish taken are sent to Toledo dealers for shipment. Part of the remainder are sent to Detroit, others are shipped from Monroe to towns in the interior, and others, especially of lower grades, such as herring, bull-heads, and saugers, are sold locally or peddled through the country.

A Detroit firm has, near Monroe, on the Raisin River, a freezing-house for whitefish and trout, which are mostly brought from the upper lakes. The Toledo firm also, in its establishment at Brest, salts, freezes, and smokes fish, and manufactures caviare.

About 1860 whitefish sold at $3 per hundred; the price gradually advanced to $10 per hundred in 1867 and 1868, when they ceased to be sold by count. At present they bring from 4 to 5 cents per pound.

Statistics.—The number of fishermen in 1885 was 224, besides 10 who were only occasionally employed, and there were 35 shoresmen, mechanics, and preparators. These fished 204 pound-nets, 43 fyke-nets, 4 seines, and 100 set-lines of 300 hooks each, using 133 boats. The capital invested amounted to $74,867, of which $33,400 was the value of vessels and boats, $41,725 the value of pound-nets, $900 the value of seines, $1,500 the value of fykes, set-lines, and spears, $7,970 the value of wharves and buildings, $1,000 the cash capital, and $4,170 the value of minor apparatus and accessories, including fish-cars. The products were 133,400 pounds of whitefish, 214,400 pounds of catfish and bull-heads, 837,200 pounds of herring, 91,300 pounds of sturgeon, 220,000 pounds of wall-eyed pike (locally known as "pickerel"), 25,000 pounds of bass, 91,200 pounds of saugers, and 209,400 pounds of perch, suckers, and other fish, making a total of 1,821,900 pounds, worth $34,824. These figures include the village of Rockwood, just north of the upper county-line; on the other hand, the little strip of Monroe County which borders on Maumee Bay is omitted, as its fisheries are entirely operated from Toledo and are naturally included with the other fisheries of Maumee Bay and River.

Pound-net fishery.—The first pound-net on this shore was set in 1857 by parties from Saybrook, Connecticut, who had previously been fishing with the same kind of apparatus in other parts of the lake. The

first nets off Swan Creek were set in 1865. At present there are twelve pound-nets at Pointe Mauillée, five just north, and three south of the mouth of Swan Creek, fifty-six at Stony Point, twelve in a string about 5 miles farther south, thirty at the mouth of the Raisin River, thirteen in a string at the mouth of Otter Creek, and sixty-seven just north of the entrance of Maumee Bay. Besides these, four nets at West Sister Island, owned in this section, are included in the statistics.

The nets used are set in water from 12 to 35 feet deep. The leaders are staked and start from 330 feet to 1,650 feet from the shore. The mesh of the leaders is from 5 to 7 inches, of the hearts and funnels from 4 to 5 inches, and of the pots or cribs 1½ inches at the sides and from 1½ to 4 inches on the bottom. While the mesh used in pots and funnels is now of the same size as formerly or a little larger, that of the leader and hearts has been increased in size, as the larger mesh is cheaper, and, by offering less resistance to the currents, causes less strain upon the stakes and lines, while it is claimed that it is just as effective in guiding the fish into the crib. The twine for the nets comes from manufacturers in the East, sometimes directly, but more commonly through dealers and agents at Toledo. The fishermen buy it by the pound already knit into strips and sheets of various sizes and shapes according to order, and they cut, seam, and tar it themselves.

Most of the pound-nets are fished throughout the season of open water, except during the months of July and August. About forty, however, are not put in until September and a dozen others are set only in the spring.

The total value of the two hundred and four pound-nets in 1885 was $41,725. These were fished by one hundred and two fishermen, who used sixty-nine boats.

Seine fishery.—Four seines, 96 to 440 fathoms long and 14 to 16 feet deep, were used in Pleasant Bay and at the mouth of Raisin River in 1885. The fishing is carried on continuously from November 15 to May 15. Mr. Bower says: "When the bay is frozen over the bottom lines are held in position by stakes set in a circle and frozen in the ice, and at every haul another line is drawn into position. The first line is laid before the ice has formed." Large holes are kept open at intervals through which to drop and spread the seine, and the ice is also removed at the landing point on the shore. About one-quarter of the catch, in weight, consists of bull-heads, weighing about half a pound each. The remainder is made up of black-bass, rock-bass, grass-pike, "pickerel," perch, saugers, suckers, herring, and red-horse. The bass, pike, and pickerel bring, on an average, 6 cents a pound, the bull-heads 2½ cents, and the others 2 cents. The business is profitable, as the price in winter is much better than could be obtained during the summer months.

The number of men who are engaged exclusively in the seine fishery is ten, besides several others who are already included as pound-net

fishermen. The total value of the four seines was $900, and of the four boats $100, and the products amounted to 88,000 pounds, worth $2,800.

Fyke-net fishery.—Between October 15 and April 15 a number of fyke-nets are fished for the same species as are taken in the seines. They are located as follows: Six in Huron River near its mouth, sixteen within the mouth of Swan Creek, and fifteen in Plum Creek and Pleasant Bay. Each fyke consists of two staked and anchored funnels of netting, each 12 feet long, one opening into the other, and a 190-foot leader. The first funnel has a mouth 4 feet in diameter and an opening at the small end of a diameter of 1½ feet. The second funnel has an aperture of 3 feet at one end, and is closed at the other. Some of the fykes have wings 12 feet long on each side of the mouth, extending at an angle of 45 degrees. The size of mesh in the funnels is 1½ inches, and in the leader and wings 3 inches. The fish are removed by lifting the small end of the second funnel, which is closed with a puckering string, and taking them out with a dip-net. In the winter the nets are set at some distance below the surface, in order that they may not be frozen in.

There are seven fyke-net fishermen, whose five boats are worth $50, their forty-three fykes $382, and their minor apparatus and accessories $30. The products amounted to about 85,000 pounds, worth $2,400.

Set-line fishery.—A special class of the population, of Canadian-French descent, commonly known in the locality as "muskrat Frenchmen," make their living partly by the cultivation of their little farms along the shore and partly by fishing and muskrat catching. Their fishing is limited to the setting of lines for catfish and mud-turtles between the 1st of June and the 1st of September. The apparatus used consists of from 200 to 400 hooks attached by short lines to a main line which is from 5 to 27 fathoms long, according to the place in which set, and is held in place by poles or stakes pushed into the mud. The lines are usually set in the lake, but occasionally short ones are fished in the bayous and marshes. Catfish are taken with a bait of herring or grasshoppers, and are mostly used in the families of the fishermen and their neighbors or sold to peddlers. When the catch is large the surplus fish are dressed for market; their heads, skins, entrails, fins, and tails are removed and they are then shipped fresh to Toledo. A few of the fishermen keep them in live cars until there are enough for a shipment. The size of the catfish ranges from 5 to 25 pounds, averaging 8 or 10 pounds.

In fishing for mud-turtles, the lines are set 3 to 6 inches below the surface of the water, and are baited with pieces of herring or frog. The turtles weigh from 6 to 15 pounds each, and are usually shipped alive in boxes to Toledo and occasionally to Detroit.

There are from sixty-five to one hundred men engaged in this fishery, using one hundred set-lines, worth $1,000. The catch in 1885 consisted

of 150,000 pounds of catfish, worth $1\frac{1}{2}$ cents a pound, round, and 24,000 pounds of mud-turtles at 2 cents a pound.

Winter spear-fishery.—For from one to three months in winter twenty-five to thirty men engage in spearing pickerel through the ice near the breakwater south of Monroe light-house. Some of them do so simply for amusement, or to supply their own families, but about half the number make it a business. Each of the fishermen takes with him a shanty, sometimes on runners, a spear and a decoy fish, and occasionally a small stove. The catch, which is nearly all pickerel, is disposed of in Monroe or sold to peddlers at an average price of 6 cents per pound. The average value of the outfits of these fishermen in 1885 was $15, and the average value of the catch was $2 per day to each man.

87. MAUMEE BAY AND RIVER, LUCAS COUNTY, OHIO.

General characteristics.—Lucas County extends along the south side of Lake Erie at its extreme western end for about 25 miles, and includes most of Maumee Bay and the lower portion of the river of the same name. A long arm of the bay extends northward into Monroe County, Michigan, but as the fisheries there are carried on from the Maumee River, and are naturally included in the present section, they were omitted from the statistics of Monroe County. There are no settlements on the lake shore of Lucas County, but the important commercial city of Toledo is situated on the left bank of Maumee River, 5 miles from its mouth, and there are several suburban villages within a few miles north and south of the city.

The fisheries of Toledo are important, and the fish trade especially so, as the dealers here handle nearly five-sixths of the entire production of the fisheries between Detroit River and Touissant Creek.

Fishermen.—Most of the fishermen of the Maumee River live in Toledo or still higher up the river at the villages of South Toledo and Perrysburgh. Of the Maumee Bay fishermen about three-fourths live at North Toledo and Ironville, between the city and the bay. A third part of the population of these two villages is directly or indirectly dependent upon the fisheries. The fishermen are chiefly Americans, or of French-Canadian or German extraction, and they are generally intelligent and industrious.

Wages.—The wages paid to the fishermen are $25 per month, with board, to new hands; $35 to $50, with board, to trained fishermen; and $60 to $80, with board, to foremen.

Apparatus.—The apparatus used are pound-nets, seines, fykes, and set-lines, of which the first named are employed to a much greater extent than any other. The pound-nets are set all along the shores of the bay and lake and in the mouth of the river; the fyke-net fishing is in the northern arm of the bay, and the seining-grounds are in the river above Toledo. There is considerable set-line fishing for catfish between Bay Point and Locust Point. The nets used are made by Eastern manu-

facturers and are bought by weight. The fishermen do their own tarring and seaming.

Species.—The principal fish taken in the bay and river are bass, wall-eyed pike (locally called "pickerel"), saugers, catfish, bull-heads, perch, and suckers. The catch of saugers is very extensive, and Toledo is probably the largest market for this species on Lake Erie. The spring catch is much greater than that in the fall, as many kinds of fish ascend the river at that time for the purpose of spawning. Whitefish and herring once entered the bay in small numbers, and sturgeon ran up the river by hundreds as far as the rapids above Perrysburgh, but at present these three species are entirely absent. East of Cedar Point, just outside the entrance of the bay, they may still be taken in considerable numbers during the spawning season and for a short time in the spring, although it was conceded by all that whitefish and sturgeon were very much scarcer in 1885 than formerly throughout the region tributary to Toledo, and, in fact, were less abundant everywhere in the western end of Lake Erie. Very few whitefish with eggs fully matured were taken in these waters during the spawning season until 1883, since which time the percentage of fish with ripe roe has increased so much as to enable the State commissioners to obtain all the eggs needed for the Toledo hatchery from the nets on these grounds. This increase in the catch of spawning-fish is attributed chiefly to the fact that the pound-nets extend out much farther into the lake than they formerly did.

Trade and preparation of products.—As has been remarked, the fish trade of Toledo is of considerable importance, both the outside shipments and the local consumption being quite extensive. There are some half a dozen firms of fish dealers in the city who handle altogether about 3,850,000 pounds of fish, including 220,000 pounds of whitefish, 615,000 pounds of "pickerel" (wall-eyed pike), 52,000 pounds of blue pike (a variety of the same species), 65,000 pounds of bass, 255,000 pounds of sturgeon (including oil and caviare), 160,000 pounds of catfish, 1,150,000 pounds of herring, 830,000 pounds of saugers, and over 500,000 pounds of perch, suckers, and other species, the whole having a first value of $141,200. Most of the trade is in fresh fish, but four of the firms have freezers, in which are frozen yearly a total of 125,000 pounds of whitefish, 490,000 pounds of herring, 15,000 pounds of wall-eyed pike, 30,000 pounds of sturgeon, 40,000 pounds of saugers, and 20,000 pounds of other fish, chiefly perch. Three of these same firms put up, altogether, 3,500 packages of herring and 2,500 of saugers in brine.

One firm included in its operations the smoking of herring and sturgeon and the preparation of caviare, isinglass, and oil. Sixty thousand pounds of herring and the same quantity of sturgeon were smoked, and 75,000 pounds of caviare, 1,000 pounds of isinglass, and 500 gallons of oil were prepared.

Whitefish and herring are frozen "round" in shallow galvanized pans. A few "dressed" herring were frozen during 1884 for the first time. The herring for smoking are strung on wire rods and placed in brick ovens over a smoldering fire of hard wood.

The barrels for salt fish come chiefly from Sandusky, only a few being manufactured at Toledo.

The amount invested in the fish trade, which is included in the general statistics of the fisheries given further on, is over $56,000, of which about $42,000 is the value of buildings and wharves.

Fish brought from other localities.—The supply of some species of lake fish obtainable from this portion of Lake Erie is not sufficient to meet the demands of the trade. More than half of the sturgeon now handled are brought from Lake St. Clair and other waters, and it is also found necessary at times to have whitefish shipped here from the eastern portion of the lake, usually from Erie, and from the upper lakes, in order to obtain a sufficient quantity to fill the dealers' orders and to restock their freezers.

Sturgeon smoking and manufacture of caviare.—According to Mr. Samuel Curry, an old resident of Toledo of much experience in the fisheries, sturgeon were not used for food in this region until 1860, when their utilization by smoking was begun in Sandusky. Before that date they were considered valueless and treated as a nuisance. They were usually taken out of the water and thrown away, but sometimes they were allowed to escape alive, and occasionally the fishermen would wound several of them before letting them go, thinking that the bloody water would keep others away. The first which were prepared for market were dressed, pressed, and smoked whole for ten days, and were afterward sold as smoked halibut, as, indeed, most of them still are. At present the fish are cut in slices, brined, and then broiled, and smoked for from three to six hours.

The earliest caviare making on Lake Erie, according to Mr. Curry, was undertaken at Sandusky in 1855 by Mr. Bloom.

Regarding the manufacture of this article Mr. Bower says:

> It is made from the roe of sturgeon, which is washed and worked in brine and passed through hard sieves to disintegrate the mass and eliminate the glutinous matter. It is considered very perishable, though some manufacturers claim to be able to make an article that will keep in ordinary temperatures. It is, however, almost invariably held and shipped in cold storage. Various preservatives and antiseptics have been tried with more or less success, chiefly salicylic acid, which is probably the most efficacious. The best caviare is made from full-grown roe or that which is nearly ripe. It is put up in casks holding 130 to 150 pounds, and shipped to New York, whence most of it goes to Hamburg and Bremen, Germany. Local consumption is very light, though the home demand is increasing.

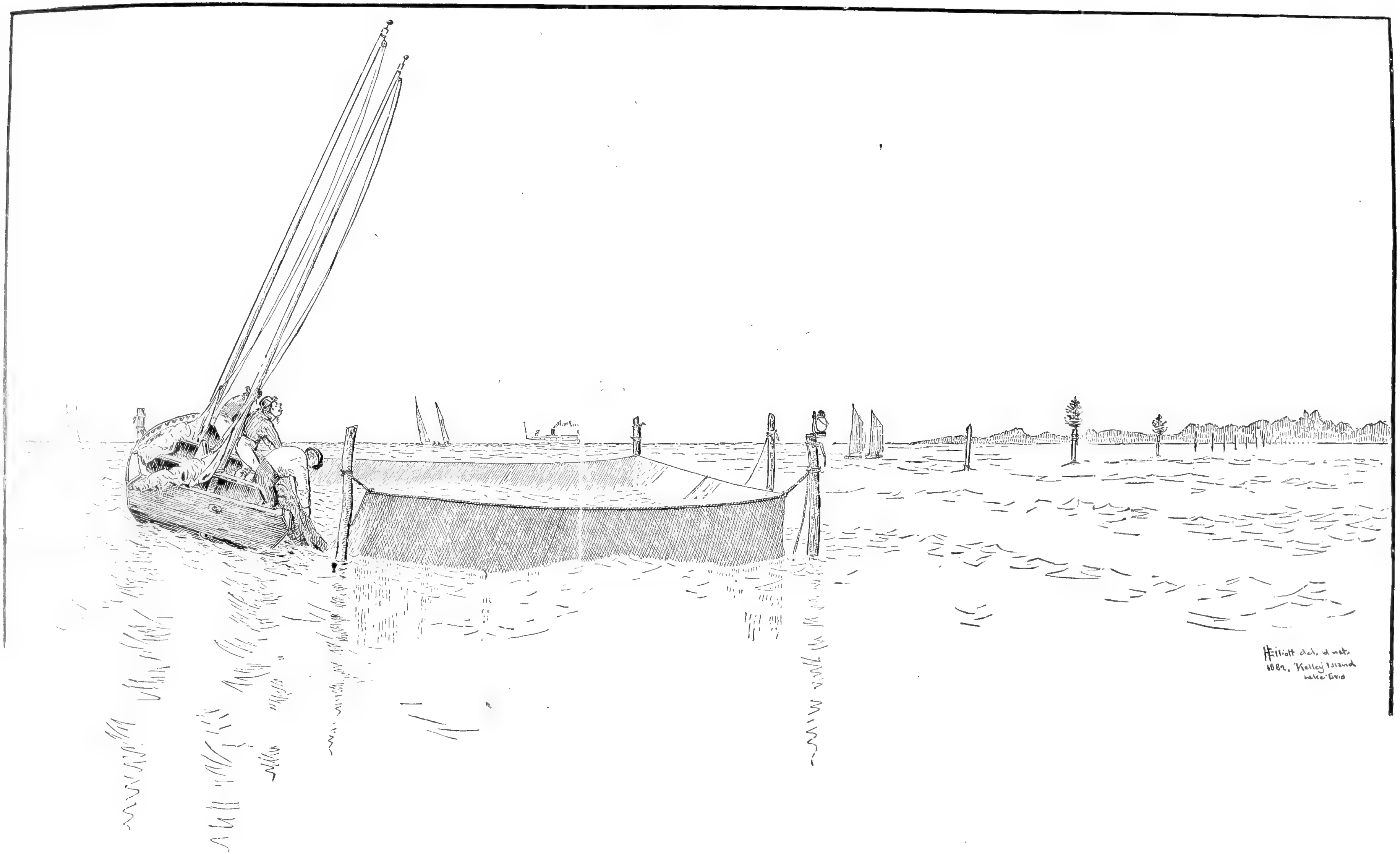
Statistics.—There were 509 fisherman engaged in the fisheries of the Maumee Bay and River section in 1885, of whom 429 fished regularly for profit, besides 67 persons employed in mending nets, preparing fish and doing other shore work directly connected with the fisheries. The number of persons dependent upon these for support was nearly 1,400.

There were 3 steamers employed in collecting fish, 42 seine-boats, and 237 other boats, including pound-net boats, scows, and small row-boats. The value of the steamers was $16,300, and that of the other boats was $10,095. The number of pound-nets was 242, of seines 44, and of fykes 39. The total value of pound-nets, seines, fykes, and set-lines was $47,890, and that of the wharves and buildings used in immediate connection with the fisheries was $49,205; the value of accessories, including fish-cars, was $8,192, and the cash capital was $10,500. The products amounted to 3,400,350 pounds, having a value to the fisherman of about $61,000, and divided as follows: 1,232,200 pounds of saugers, 641,000 pounds of herring, 635,300 pounds of wall-eyed pike, 274,450 pounds of catfish and bull-heads, 79,000 pounds of whitefish, 70,000 pounds of bass, 15,000 pounds of trout, and 463,400 pounds of other species.

Pound-net fishery.—It is said that the first pound-net set in the western end of Lake Erie was put down in Maumee Bay about 1850. It is certain, however, that these nets did not come into general use until between 1860 and 1870 when they were introduced rapidly all along the lake shore from Huron westward.

In 1885 the fishery was very extensive and there were one hundred and seven nets in the bay and the mouth of the river, and one hundred and thirty-five on the lake shore between Cedar Point and Toussaint Creek, including several set at West Sister Island. The lake nets are set in water from 12 to 30 feet deep and are of the ordinary dimensions, but the others though the same in form are much smaller. These bay nets vary in size, those in the mouth of the river being the smallest. They are set in water from 3 to 13 feet deep, and the ground is of such a nature that the stakes can be easily driven, and a hand-maul is usually sufficient to fix them securely in place. In these nets the leader is from 33 to 41 fathoms long, the hearts 8 to 14 fathoms long, the tunnel 12 to 14 feet long, and the pot 12 feet square. The size of mesh is usually about 3½ inches in the leader, 3 inches in the hearts and funnel, 2¼ inches in the pot. At first the pound-nets were set singly or in strings of from two to four, and this is still the case in the bay, but on the lake shore they have been pushed farther and farther out until now between Cedar Point and Touissant Creek the nets are arranged in nine strings of twelve, thirteen, sixteen, or seventeen nets each. The fishing season is from the going out of the ice in the spring until May 15 or June 5, and in the fall from September 10 or 20 until the lake freezes. Most of the nets are set both in the spring and fall, but twenty-five which are set in the bay near the mouth of the river are fished only in spring. Over fifty of the bay pound-nets are owned at the town of North Toledo and about forty at Ironville. Nearly the whole of the remainder, including all the lake nets, are owned by the dealers and other firms at Toledo.

Seine fishery.—According to Mr. John Wygant, an old resident and fisherman of Toledo, seining was begun in a small way in Maumee River



"LIFTING THE POT" OF A POUND-NET, LAKE ERIE.

Drawn by H. W. Elliott.

seventy years ago. At that time fish were very abundant, the local trade was small, and there were no facilities for shipment; so only about one-twentieth of the catch could be disposed of, and after this small portion had been taken out to supply the local trade the rest of the fish were released. The fishing was of small extent until about 1850, but during the next decade it became very important, and then reached its greatest development.

The first seine used outside of Maumee Bay in this portion of the lake was a small one fished in 1854 off Cedar Point, near the entrance to the Maumee Bay. The great success of this attempt soon led others to imitate it, so that in two or three years between five hundred and six hundred men were fishing with seines between Cedar Point and Locust Point. The catch was very large and consisted of the same species which are now taken in the pound-net on the same grounds. Sturgeon were so abundant that as many as two hundred were sometimes taken at a single haul. This species was not considered of any value, but the other kinds were salted immediately and shipped to the dealers at Buffalo and Cleveland, and in later years by the Miami Canal to Dayton and Cincinnati. In the fisheries of the lake shore the seine was gradually superseded by the pound-net, and by 1865 its use had been almost wholly abandoned.

The river seine fishery, on the contrary, is still flourishing, though the catch has decreased considerably in the last five or six years. The grounds extend from a mile above Toledo to the rapids, 12 or 14 miles up-stream. The fishing begins as soon as the ice goes out in the spring, which is sometime during the month of March, and lasts about four weeks. In 1885 one small seine was fished in the fall. The bulk of the catch is taken before the bay pound-nets are ready for work, as the ice moves out of the river several days before the bay is open. The seines used have a mesh of 2½ inches. Their length varies from 165 to 1,150 feet, averaging about 500 feet, and their depth from 9 to 14 feet, averaging 10½ feet. The seining grounds belong to farmers who live along the river. Some of them are rented, but the greater part are fished on shares, the owners of the grounds furnishing the seines and outfits and receiving one-half of the catch. Before 1879 or 1880, when the river swarmed during the spring run with French Canadians who came here at that time to fish, the grounds commanded a high rent, and even now favorite sites can be rented for $300 to $500 for a single season. Each landing place has a shanty or two and a windlass for hauling the seine. A horse is hired, at 50 cents a day and keeping, to turn the windlass.

There are only one or two seines in Maumee Bay, and these are not only fished in spring, but, unlike the river seines, are also hauled in winter under the ice.

About 1850, when the seining in the river first began to be important, the farmers visited the vicinity from many miles around to exchange

their produce for fish, and such portion of the catch as could not be disposed of in this way was salted and sold to dealers at Cleveland and Buffalo. At present the fish caught are put up in barrels and carried to the dealers in wagons, except where the landing is on an island, when a boat is used instead. Most of the catch is sold to the Toledo dealers, but about 40 tons are handled at Perrysburgh, from whence they are shipped fresh to retailers in central Ohio. The seine fishermen obtained much better prices for fish than those using other apparatus.

At a meeting held in Toledo in the winter of 1884–'85 to oppose the prohibition of seining in the river it was claimed that about a thousand persons were dependent upon this branch of the fisheries, but Mr. Bower observes that this figure is probably somewhat exaggerated. The statistics collected show about two hundred and thirty seine fishermen with at least six hundred people dependent upon them for support. The catch in 1885, which was an unfavorable year on account of the ice remaining much later than usual, consisted of 250,000 pounds of saugers, considerably over 300,000 pounds of wall-eyed pike, including a few bass, and 170,000 pounds of other fish, mainly suckers, mullet, redhorse, and perch; for the whole of which the fishermen obtained nearly $20,000.

Fyke-net fishery.—The fyke-nets of Maumee Bay are much larger and better than those about Monroe. They are somewhat similar to the small pound-nets and are quite as effective. Instead of wings they have a leader and set of hearts. The leader is 30 to 70 fathoms long, the hearts 8 to 14 fathoms long, and the bowl or pocket 12 to 14 feet long. The mesh is 4 to 5 inches in the leader, 3 inches in the hearts, and 2½ inches in the bowl. Their value ranges from $25 to $50 each. The total number in Maumee Bay was thirty-nine, worth $1,710. There are none in the river or along this part of the coast. They are fished in the spring and fall, and occasionally in winter.

Set-line fishery.—There are about one hundred and fifty men who fish for catfish between Bay Point and Locust Point from April 15 to the middle of August. Over half of these own small farms along the shore, to which they give almost their entire attention, and fish only occasionally and to a small extent. The others make a business of it, but nearly all of these likewise live on or near the coast, so that but a few find it necessary to have fishing shanties. Each man has a set-line with from 500 to 2,000 hooks, a row-boat, a dip-net, a cleaning-knife, and a pair of pincers. The value of this outfit averages $25. The fish are dressed on the grounds by those who catch them, losing one-half of their weight in this process, and are mostly sold to the dealers at Toledo at 4½ cents a pound. A single firm handles over 50,000 pounds of dressed catfish yearly from this source. The total catch of these fishermen in 1885 brought them about $6,000.

88. LOCUST POINT TO PORT CLINTON, OTTAWA COUNTY, OHIO.

Toussaint Creek.—Immediately east of the promontory known as Locust Point, the limit of the fisheries tributary to Toledo, is Toussaint Creek, a stream whose mouth affords a good harbor for small fishing craft. The fisheries at this point are quite varied, most of the apparatus and methods of Lake Erie being represented. There are about thirty fishermen here, using two steamers, twenty-two boats, one hundred and thirty-five gill-nets, thirty-five pound-nets, thirty-three fykes, and thirteen thousand set-line hooks.

Portage River.—From Locust Point the trend of the lake shore is in a southeasterly direction to the broad, shallow mouth of Portage River, beyond which it bends abruptly to the northward until near Moore's Point, Catawba Island, it recurves a little towards the west before again resuming its eastern and southern direction. At the mouth of the Portage River, on its southeastern bank, is the town of Port Clinton, the most important one between Toledo and Sandusky, one-half of whose population of 2,000 are directly or indirectly dependent on the fisheries. The harbor is a good one for craft drawing 9 feet or less.

General characteristics of the fisheries.—The fishermen of this region are intelligent and industrious, and are mostly men of American ancestry, living at Port Clinton and Locust Point. A firm at the former place owns thirty pound-nets, which extend out 10 miles from the land and form the longest string of pound-nets in the waters of the United States. They purchase large quantities of fish from other fishermen in the vicinity, including nearly all the products of the winter fisheries of Portage River and the west end of Sandusky Bay. They make their own boxes, barrels, and boats, and are also agents for the sale of netting. There is a small number of pound-nets near Port Clinton in addition to the great string just referred to, and in the neighborhood of Toussaint Creek there are about three dozen more. A score of gill-net crews fish from the two places, whose favorite fishing-ground is Niagara Reef, about 7 miles northeast of Locust Point, 12 miles northwest of Port Clinton. The seine fishery, though greatly diminished by the introduction of pound-nets nearly thirty-five years ago, has survived to the present time in Portage River and at the western end of Sandusky Bay. Fyke-nets are fished both in Toussaint Creek and Portage River, each place having several score; and in summer nearly all of the fishermen use set-lines, principally for catfish. There is also a number of persons who make a living by catching frogs and mud turtles.

Species.—In the early days of the fisheries, thirty or thirty-five years ago, sturgeon, herring, and all kinds of "soft fish" were thrown away, as there was no market for them, and whitefish were usually the only kind saved. They were very abundant, and it is related that in 1851 as many as 2,500 fish of this species were caught near Port Clinton in a single haul of the seine. Mr. Bell, one of the most experienced fish-

ermen of Port Clinton, gives the following as the result of his observations regarding the abundance and size of fish: The number of whitefish caught annually in the lake is as large as at any time in the past, the smaller number to each net resulting from the great increase in the amount of apparatus employed. Herring are scarcer in the vicinity of Port Clinton than formerly, and the number of sturgeon has decreased rapidly in the past ten years. There is no observable change in the average size of fish except in the case of herring, which have increased in size. The average size of the whitefish caught in pound-nets is 3½ pounds, while those caught in gill-nets on the spawning reefs average 4½ pounds.

Trade.—A large proportion of the yield of the fisheries of this shore is handled at Port Clinton, where there is a capacious freezer, in which, in 1885, 90,000 pounds of whitefish, 10,000 pounds of sturgeon, 240,000 pounds of herring, and 30,000 pounds of perch and wall-eyed pike were frozen. Another market is at Locust Point, where sturgeon are purchased from the fishermen and caviare and isinglass are prepared for market. When the first demand for sturgeon began, in 1872, the fishermen were anxious to dispose of their fish at 18 cents each, but the ruling price of late has been $1 each, irrespective of size. At Toussaint Creek almost all of the fish are shipped fresh by "running boats," also called "fresh-fish boats," to Port Clinton, Sandusky, or Huron, and sometimes to Toledo. The quantity of salt fish put up or handled by the dealers was 80,000 pounds, of which 50,000 pounds were herring and the rest saugers. The fresh fish handled amounted to considerably over 2,500,000 pounds, divided as follows: Whitefish, 60,000 pounds round, with a value to the fishermen of $4,200; bass, 35,000 pounds, valued at $2,100; wall-eyed pike, 58,000 pounds, valued at $3,480; herring, 800,000 pounds, valued at $10,000; sturgeon, 75,000 pounds, valued at $1,800; saugers, 1,000,000 pounds, valued at $15,000; bullheads and catfish, 500,000 pounds, valued at $15,000; miscellaneous "hard fish," principally grass pike, 32,000 pounds, valued at $1,600; and miscellaneous "soft fish," principally perch and suckers, 115,000 pounds, valued at $1,725. Fourteen hundred pounds of caviare worth $166, 27 pounds of isinglass, worth $38, and 2,500 gallons of oil, worth $1,125, were prepared. Formerly large quantities of frogs and turtles were caught in the marshes along this strip of coast and were handled by the Port Clinton dealers. Although the number has fallen off greatly, 5 tons of turtles and several hundred dozen frogs were handled in 1885.

Statistics of fisheries.—The number of persons employed in the fisheries in 1885, from Toussaint Creek to Port Clinton, inclusive, was 187, of whom 132 were fishermen, 22 shoremen, 31 preparators, and 2 mechanics. The total number of persons dependent upon these men was 416. One steam-vessel worth $500 was employed in fishing, and two worth $13,000 in collecting fish. Four sail-boats, valued at $1,500, were also collecting. The other boats used were 13 gill-net boats, 5 pound-net boats, 6 seine-

boats, 6 scows, and 70 small boats, or 100 in all, worth $7,065. The apparatus used were 980 gill-nets, valued at $2,088; 73 pound-nets, worth 22,475; 6 seines, worth $1,200; 76 fykes, valued at $966; 110 set-lines, with 90,800 hooks, worth $1,850. Twenty-seven fish-cars, worth $486, were used by the dealers. The value of other apparatus and accessories was nearly $6,000, and that of the shore property was $38,795. The dealers had a cash capital of $5,000.

The products consisted of 160,000 pounds of wall-eyed pike, 49,000 pounds of bass, 146,500 pounds of whitefish, 995,000 pounds of herring, 577 pounds of bull-heads and catfish, 36,000 pounds of sturgeon, 1,012,000 pounds of saugers, 275,000 pounds of perch, sunfish, and suckers, and 58,500 pounds of miscellaneous fish, principally grass-pike. The total quantity was thus over 3,300,000 pounds, having a value to the fishermen of $52,500.

Pound-net fishery.—Mr. Bell says that a pound-net which he helped to fish 5 or 6 miles west of Port Clinton, in the fall of 1852, was the first one set in Lake Erie outside of Maumee and Sandusky Bays. Pound-nets were used the same fall near Port Clinton and off Marblehead with excellent success, and the number continually increased until 1885, when there were thirty-five just east of Locust Point and thirty-eight near Port Clinton.

The one first set was made by cutting up two seines, and differed in some respects from those now in use. No funnel was used, and the heart led directly into a large and awkward pot or "crib," circular in form. The circumference of the crib was 198 feet, and the length of the leader 825 feet. Most of the pound-nets now in use are fished both in spring and fall, though there is an insignificant number which is set only in the fall. On account of the exceptional shallowness of the western end of the lake, and the levelness of the bottom, there is no natural limit to the number of pound-nets which can be set in a single string, and they might with perfect facility be set one after another entirely across the lake. The nets at Locust Point are set in four strings, two of which, containing five and twelve or fifteen pounds, respectively, start from points about 5 miles from land, the shortest running out to Niagara Reef and the other beyond it. The catch in these nets is much better than in the ones nearer shore. The depth of the pound-nets for the whole region varies from 12 to 35 feet, averaging a little over 20 feet. The deepest net in the 10-mile string at Port Clinton is 30 feet, and the shoalest is 16 feet.

Gill-net fishery.—Gill-nets are fished in spring, principally for saugers, near the shore and in the mouths of the rivers; and in the fall, from the latter part of October to the 1st of December, for white-fish on Niagara Reef.

The sauger nets are 33 fathoms long and 5 feet deep, with a 2½-inch mesh; those for whitefish on the reef are the same in depth, but are 40 to 55 fathoms long and have a 5½-inch mesh. The gill-net crews fishing

on the reef, and most of the others, are composed of four men each. The catch on the reef amounts to between $400 and $500 worth of fish annually. Gill-nets have been operated at the eastern end of the lake for saugers during several seasons, but were first tried in this section in the spring of 1885. During the short period when the fishery was prosecuted it was very profitable, and the indications were that it would become more extensive in future years. The saugers taken average 1 pound in weight and are sold chiefly in Port Clinton at 1 cent a pound.

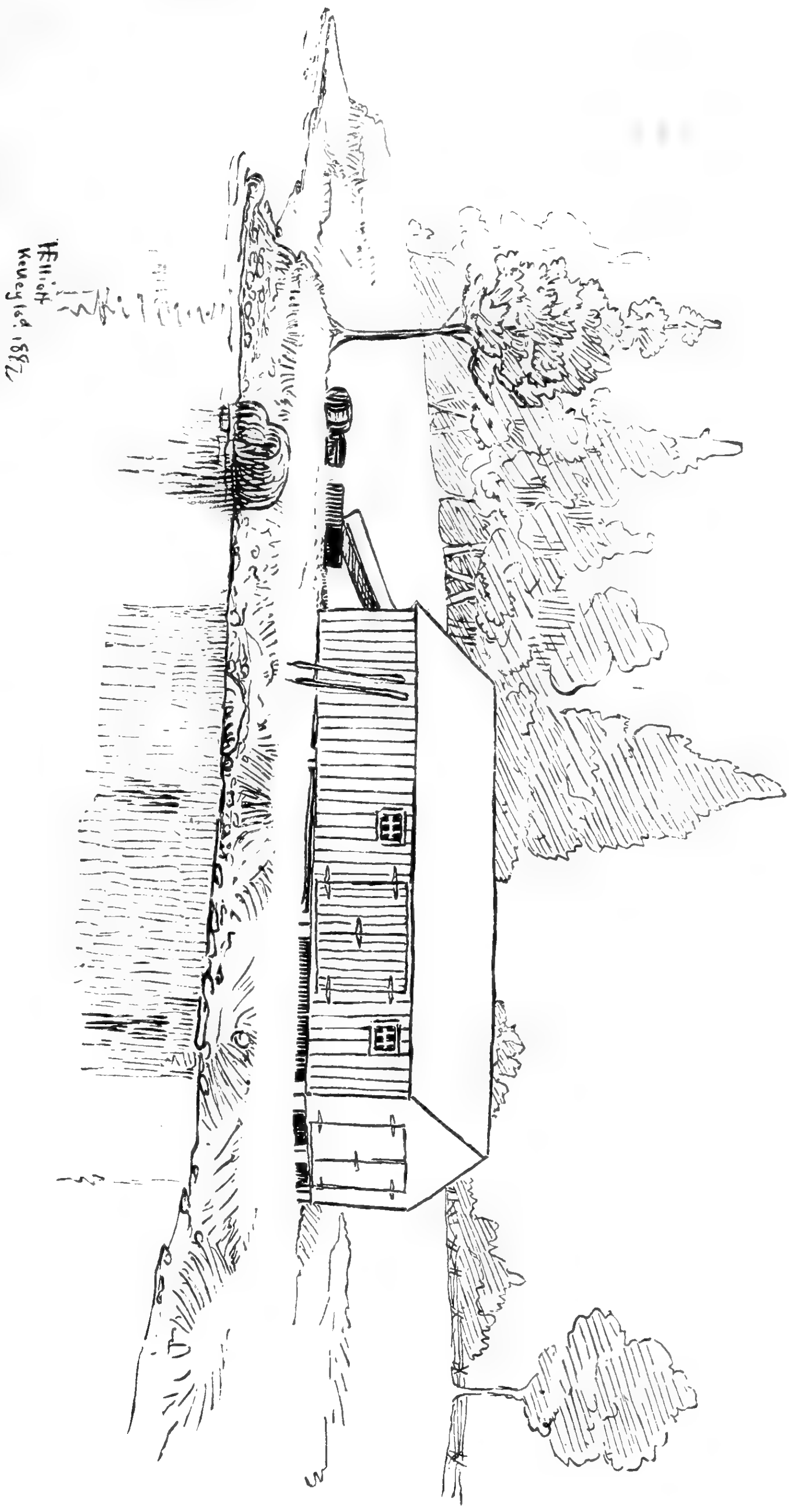
Seine fishery.—There are several Port Clinton crews fishing with seines, some in the western end of Sandusky Bay, and others in the Portage River. The seines used are 125 to 140 fathoms long, and from 12 to 16 feet deep. The season is from November to the 1st of April, and during severe winters the seines are fished under the ice most of the time. The catch consists principally of bass, bull-heads, and sunfish, besides wall-eyed pike, grass-pike, perch, and saugers. Nearly all of the fish taken are put into barrels and hauled on sleighs or wagons to Port Clinton, where they are sold. This fishery is quite profitable on account of the comparatively high price which can be obtained for fish during the winter.

Fyke-net fishery.—Three dozen fyke-nets are fished in the mouth of Toussaint Creek in winter by the fishermen of that vicinity. The fykes proper are 14 feet long, the hearts 27 feet, and the leaders 165 feet. The size of mesh is 3 inches in the leader and hearts, and 2 inches in the fyke, or bowl. In Portage River forty fyke-nets are used near the seining beaches, sometimes in winter but usually during the spring and fall, by men who give most of their time to other fisheries.

Set-line fishery.—About fifteen crews from Port Clinton and several others from Locust Point fish for catfish, with set-lines, at a distance of from 5 to 15 miles out in the lake. Small boats are used for lifting the lines, and large sail-boats are hired or borrowed to run back and forth between the shore and the fishing-grounds. The crews are composed of three or four men, each of whom has a line with from six hundred to a thousand hooks. About three-fourths of the men are professional fishermen, who fish with other kinds of apparatus during the greater part of the year. The remainder are the owners of small farms near the shore, to the cultivation of which they give their principal attention. The year 1885 was a very poor one for this fishery, and the products for the whole season were only about $75 worth per man, which is not much more than half of the usual catch. The fish are all sold at Port Clinton, at 2 cents per pound, round.

89. SANDUSKY, ERIE COUNTY, AND VICINITY, INCLUDING SANDUSKY COUNTY AND PART OF OTTAWA COUNTY, OHIO.

Geographical description.—Passing east from Port Clinton we enter upon the region of the most important fisheries of the Great Lakes, those tributary to the city of Sandusky. This region falls naturally into four



TYPE OF LAKE ERIE FISHERMEN'S SEINE-SHED AND TARRING-BOX.

Drawn by H. W. Elliott.

divisions: The "Peninsula," the Bass Islands, Kelley's Island, and Sandusky Bay.

"The Peninsula," as it is locally called, is the strip of land which separates Sandusky Bay along its whole northern side from the waters of the lakes. At Port Clinton it is quite narrow, but gradually widens and forks into two broad portions directed toward the north and east, respectively. Most of the northern portion is nearly separated from the rest of the peninsula by a narrow inlet, which connects with the lake on the northeast and approaches to within less than a quarter of a mile of it on the southwest. Although it thus lacks a little of being wholly surrounded by water, this portion of the peninsula is universally known as Catawba Island. Four or five miles north of Catawba Island lies the most southern of the Bass Islands. The eastern part of the peninsula extends just beyond the entrance of Sandusky Bay, and has the village of Marblehead at its extreme point. Kelley's Island is about 4 miles north of Marblehead light, 6 miles northeast of Catawba Island, and the same distance southeast of South Bass Island. Sandusky Bay is accessible only through a comparatively narrow channel, as a long narrow spit called Cedar Point extends from the southeast nearly across its mouth. The pound-nets running out from this spit are the eastern limit of the fisheries carried on from Sandusky.

The fisheries of Sandusky Bay are quite distinct in their general character from those of the open lakes, though both are very extensive.

Apparatus and species.—On the outer shores of the peninsula and of Cedar Point and about the islands the most abundant species are whitefish and herring, but in the bay these do not occur, and the objects of pursuit are principally perch, saugers, bass, bull-heads, and other species characteristic of the bays and river mouths. Pound-nets are the most popular form of apparatus in the former section, where their number exceeds three hundred, though thousands of gill-nets are fished in the vicinity of the islands, and eight steam-tugs and a large number of sail-boats devote themselves to this branch of the industry. All the fishing of the bay, with the exception of a little seining at the western end, is by means of fykes and small pound-nets, which dot its shallow waters to the number of nine or ten hundred. Several seines are fished from the peninsula, both on the lake and the bay sides, and the fyke-nets so numerous in the bay are also found in considerable numbers on the lake shore, though not used to any extent upon the islands. In summer several score of men on the peninsula and a third as many more on the islands fish for catfish with set-lines; and in winter a little fishing is carried on with lines through the ice which gathers between the islands and with spears in the harbors of the peninsula. There is considerable angling for black bass and other species by summer visitors to the islands, which will be referred to fur-

ther on, though it comes only incidentally within the range of a review of the commercial fisheries.

The peninsula.—The peninsula is thickly settled with fruit-growers and fishermen. There is a hamlet, called Ottawa City, with about 150 people, on the east shore of Catawba Island, and on the north shore of the other arm of the peninsula are the settlements of Lakeside and Marblehead. According to Mr. B. Clemons, an old fisherman of Marblehead, the first pound-net used in this region was brought from Connecticut in 1850 and set near Lakeside. Mr. J. H. Klippart states that in October, 1851, a small pound-net was set at the mouth of East Harbor; its stakes were driven with a hand maul in 16 feet of water. Notwithstanding the smallness of the net it caught immense quantities of whitefish. These experiments do not seem to have produced any important results, for in 1853 the fisheries were carried on exclusively with seines, and it was not until 1855 that a pound-net was again fished there. The seine fishing along the outer shore has now almost ceased, while the pound-net fishing between Port Clinton and the entrance to Sandusky Bay has become very extensive, the number of nets between Port Clinton and the entrance to Sandusky Bay amounting, in 1885, to over one hundred and thirty. The headquarters for most of the pound-net fishing is at Moore's dock on the west side of the island.

The sauger gill-net fishing, which was begun at Port Clinton and on Catawba Island in the spring of 1884, proved so profitable that a much larger number of men took part in it in 1885, and the catch was so large as to overstock the market, causing a great depression in price.

On the northern part of the peninsula, in the crotch between its two arms, are three marshy inlets with a total area of several thousand acres, which for about fifteen years have supported fyke-net fisheries of some importance. At present one hundred and seven nets are fished here, by eight fishermen, from the beginning of September to the 1st of May. The catch consists principally of bull-heads and sunfish in fall, of bass in winter, and of grass-pike in spring, with a large mixture of perch at all seasons. In summer over fifty men fish here with set-lines for cat-fish, usually earning about $100 each during the season, though in 1885 they made only about half as much. A steam-boat touches daily at two points on the island, and during the season of navigation takes all the fish in a fresh state to Sandusky. The products of the small fisheries with spears and lines in winter and with seines in the harbors at other seasons are sent principally to Port Clinton.

The Bass Islands.—This group consists of three main islands of irregular shape lying due north of Catawba Island. Middle Bass Island is 1½ miles south of North Bass Island, and is separated from Put-in-Bay or South Bass Island, the southernmost of the group, by a channel only one mile in width.

On the northern side of Put-in-Bay Island is a roomy harbor, which is deep enough to admit the largest lake craft and which, having Middle

Bass Island to protect it from the northern winds, is sheltered on all sides and is probably the best harbor upon the whole lake. After the famous naval battle near West Sister Island (about 16 miles west by north from North Bass Island), in 1813, Commodore Perry "put in the bay" with his fleet, and from this circumstance the harbor and island have derived their names. On the west and north the coast of the island is high and rocky and the lake bottom composed of mud and clay; on the east and south the coast is low and gravelly and rocks take the place of clay upon the bottom. The first settler was Seth Doane, who came to the island in 1811, but it was not until between 1830 and 1840 that the population reached any considerable number. At present there are 800 to 1,000 inhabitants. Regular lines of steamers connect the island with Detroit, Toledo, Sandusky, and Cleveland, and in summer bring hundreds of excursionists to the island daily, thus doubling the population during that season. The harbor is well adapted for the penning of spawning fish, and the Ohio State hatchery at Sandusky has been supplied with whitefish eggs from this point.*

Pound-nets were set from this island soon after their introduction into the lake. The first were used in 1852. The number of pound-nets is now about forty-five, including those on the small outlying islands known as Balance, Rattlesnake, and Green Islands. Many of the nets are set singly; others are in strings of four to six. A number of them start directly from shore, with the lines from the leader made fast to a tree or some other object on the land. In the fall of 1885 there were four or five steamers fishing with gill-nets from this port, besides several sailboat crews. Some of the steamers were from other ports and remained here only about a month. Some catfish are taken in summer, but there is no seine or fyke-net fishing. Before 1883 very little hook-and-line fishing through the ice had been done, but in the winter of 1884–'85 about $6,000 worth of herring, saugers, pickerel, and perch were secured in this way.

Middle Bass Island is of irregular shape and its northeast corner is continued into a narrow point about a mile and a half long with a small reef near its outer end. About one-third of the south side is of a high, rocky nature, but, with this exception, the coast-line is low and gravelly with a surrounding lake bottom of mud and clay. The first permanent settlement was made in 1838, and the population at present numbers 500, of whom over nine-tenths are Germans. The people are intelligent and prosperous.

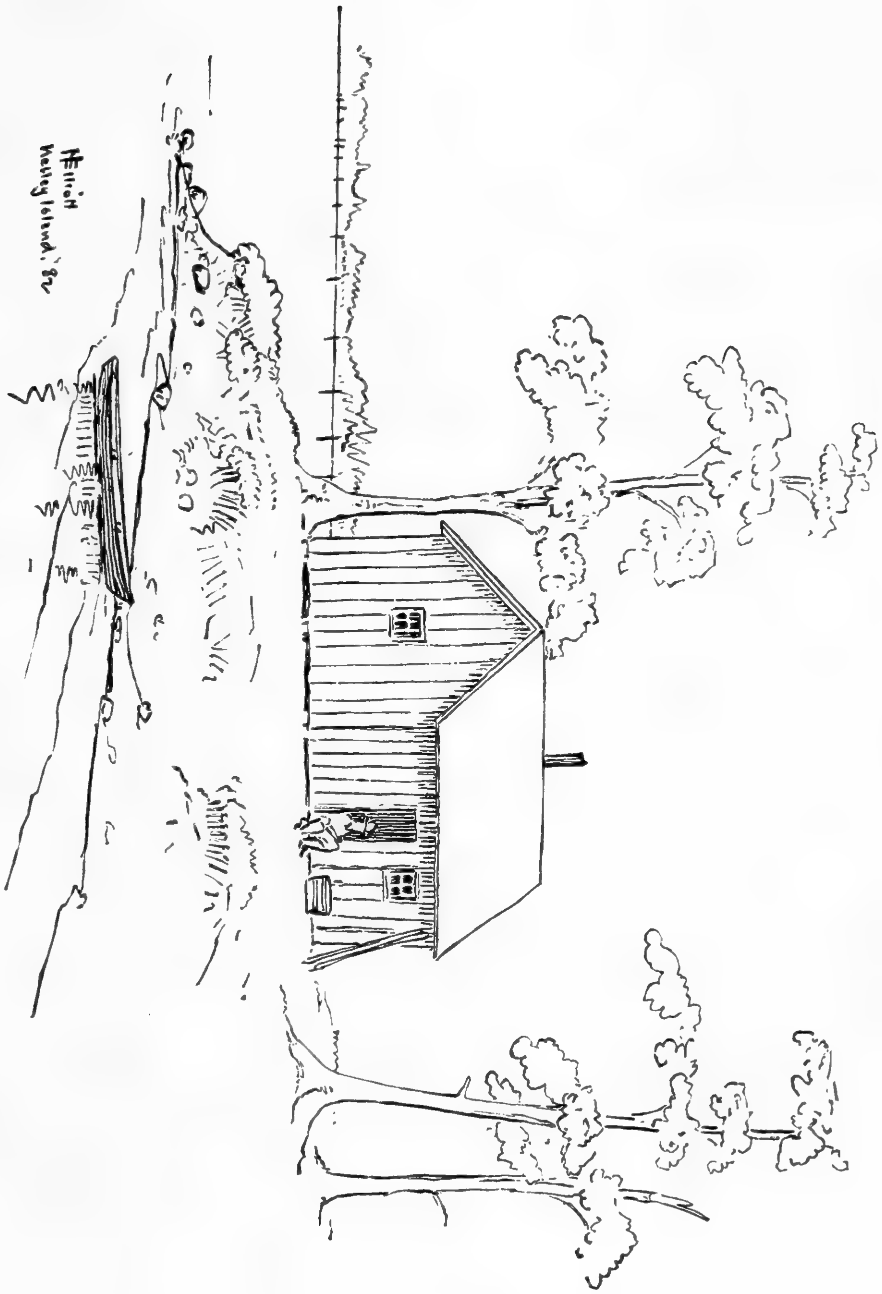
The first pound-net on this island was set in 1852. It was a tunnel-net, similar to those now in use, and Mr. William Rehburg thinks this was the first one of the kind used on Lake Erie. The number of

* The hatchery at Sandusky was put under the control of the United States Fish Commission in 1887, and in 1889 the largest fish-hatchery in the world, which will hold 500,000,000 of eggs, is being built at Put-in-Bay, Congress having appropriated $20,000 for its erection.

pound-nets is now nearly twenty. There are no seines or fyke-nets, and the only other fishing is a little catfish hooking in the summer and gill-netting by a single crew in the fall.

North Bass Island is within a mile or two of the boundary line between the waters of Canada and the United States. The first settlement was formed in 1827, and the present inhabitants number between 300 and 400; they are very intelligent and prosperous, and are for the most part Americans. The shipping facilities are not so good as in the case of the other islands, since it lies somewhat out of the route of the Detroit steamers. East and south of the island the lake bottom is composed of mud and clay, but on the north and west are reefs of honey-combed rock interspersed with small patches of clay and sand, which are probably the best spawning grounds for whitefish in Lake Erie. They extend 3½ miles into the lake from the west side of the island, and on the north side they are about 5 miles square, running some distance into Canadian waters around the little group of islands known as the Old Hen and Chickens. During the run of spawning fish, which lasts throughout the month of November, these reefs are covered with gill-nets. In the fall of 1885, for example, there were about thirty gill-net skiffs there, mostly from North Bass Island, besides six gill-net steamers, of which three were from Conneaut, two from Vermillion, and one from Lorain. The mesh of the nets used is too large to take herring and other small fishes, and the catch is almost entirely whitefish, with occasionally a few suckers. This fishery is very profitable when there are no severe storms, but at this season of the year a gale is always liable to occur, and this drives the fish off the reef. If the storm occurs in the early part of the run the fish will return, but towards the end of the season they will not. There is opposition to this fishery on the part of the pound-net men, who think that it should be prohibited by law, so that the fish can spawn without interference or interruption. According to Mr. William Axtell, the first fishing on this island was done with a seine in the fall of 1850 by himself and Mr. John Hardenbrook. The first pound-net was set here in 1852, and was of the old style, without a tunnel, as were several nets set by other parties in the following year. About fifteen pound-nets in three or four strings were set from the northern, western, and eastern sides of the island in 1885. Besides the net fisheries there were summer fishing for catfish and winter fishing with hook and line, both on a small scale.

Kelley's Island.—Kelley's Island is larger than any of the Bass Islands, from the nearest of which it is 6 miles distant, and has a population of from 1,200 to 1,500. The first settler was a French trader named Cunningham, who came here in 1808, from which time until 1840 it was known as Cunningham's Island. Few other settlers arrived until after 1825. The people are intelligent, thrifty, and prosperous, and are engaged chiefly in grape-growing, fishing, and stone-quarrying. The German element predominates. There is ample steam-boat connection with Sandusky, Detroit, and Cleveland.



TYPE OF LAKE ERIE FISHERMEN'S SUMMER HOUSE.

Drawn by H. W. Elliott.

Before 1848, though whitefish were abundant in the Detroit River, it was supposed that there were very few in Lake Erie; but Mr. Charles Carpenter, of Kelley's Island, caught several of them in that year, reporting that he had seen them in large schools, and in 1851 a few gill-nets were brought from Sandusky and fished for them with excellent success. In 1852 a pound-net was brought from Connecticut and set in the bay on the north side of the island. From that time the number of pound-nets rapidly increased, until in 1876 there were as many as fifty-seven and in 1885 there were over seventy. Mr. Bower says that the fall run of whitefish begins a week to ten days earlier here than it does at the other islands and closes that much sooner, except on the reefs. There are over forty men employed in gill-net fishing in the fall and there is some catfish hooking in summer.

Description of pound-nets and pound-net boats.—The pound-nets used in early days in the island region, as elsewhere on the lakes, were without a funnel, or rather had one which was extremely short, the hearts leading directly into the crib, pot, or bowl, as it is variously called, which was set in a circular shape. The kind now used has a long tunnel leading from the hearts to the bowl, and the latter is always square. The crib is held in position by stakes or by anchors and buoys. Sometimes stones are used for anchors, and occasionally a chain is strung along the lower edge of the netting. Some fishermen also use a chain for anchoring the hearts and the mouth of the funnel. For buoys, jugs or blocks of cedar are used. A few of the nets have a wing of netting inside the lobe of each heart, leading to the mouth of the tunnel. The leaders are from 990 to 1,320 feet long, each heart is from 132 to 198 feet in circumference, the funnel is 30 to 60 feet long, and the crib is 28 to 32 feet square. The mesh is from 6½ to 7½ inches in the leader, from 3 to 5 inches in the hearts, 3 inches in the funnel, and 2 to 2½ inches in crib. The netting is manufactured in the East, and through the Sandusky dealers reaches the fishermen, who cut, seam, and tar it themselves.

The pound-net boats are all flat-bottomed, very few being clinker built. They have two masts and carry mainsail and foresail; their capacity ranges from 5 to 12 tons.

Apparatus and methods of the gill-net fishery.—The gill-nets of the islands are hung in three ways: with corks and leads, with corks and rings, and with floats and stones. The last form is the oldest one, and is being continually displaced by the others. The floats are of cedar, and are 5 or 5½ inches long. The rings are made of five-sixteenth-inch iron and are 5 to 6½ inches in diameter. They are preferable to either stones or leads for fishing on the reefs, as they keep the net-line off from the bottom and prevent the chafing of the line or the tearing of the netting. On muddy bottom lead sinkers are preferred.

The nets used for the capture of whitefish range from 250 to 300 feet in length when hung. They are made of 35–2 cotton twine, have a

mesh of $4\frac{1}{4}$ to $4\frac{3}{4}$ inches, and are 14 meshes deep. Gill-nets for blue pike, herring, and pickerel have a $3\frac{1}{8}$-inch mesh and are from 18 to 24 meshes deep. The nets are not barked, tarred, or in any other manner treated with preservatives. The webbing is always purchased from the factories and the nets are hung by the fishermen themselves.

The gill-net fishing is carried on both from steamers and sail-boats. Each steamer carries thirty to fifty nets, which are always set at right angles to the shore and often in several strings or gangs. The nets which are to be set are stowed in unpainted pine boxes holding five or six nets each. These boxes have flaring sides and ends and in each end a hand-hole is cut to facilitate the manipulation of the boxes when they are packed full of "twine." Their average dimensions are as follows: Length on top, 3 feet 3 inches; length on bottom, 2 feet 3 inches; width on top, 2 feet 10 inches; width on bottom, 1 foot 10 inches; width of boards forming sides and ends, $10\frac{1}{2}$ inches.

The sail-boats or skiffs used in gill-net fishing are with few exceptions very much smaller than the pound-net boats. Nearly all of them are flat-bottomed and have one or two masts. There are no mackinaw boats around the islands.

Catch of pound-nets.—The spring catch in the pound-nets is chiefly pickerel, herring, saugers, black bass, perch, rock bass, sturgeon, and catfish; the fall catch consists principally of herring and whitefish, with small quantities of the other species. There is also a considerable percentage of sheepshead (*Aplodinotus grunniens*), but these are usually unmarketable, and are consequently thrown away, though for the past few years there has been an occasional demand for them at a low price from the mining regions of Ohio and Pennsylvania.

The pound-net catch of herring in the fall of 1885 was the largest ever known, so that most of the fishermen could not, with their ordinary force of men, empty their nets as fast as they were filled, and the dealers in Sandusky were not able to handle all the fish. Therefore, as most of the fishermen were not prepared to salt them, large quantities were thrown away or allowed to escape. During the heaviest run, which occurred between the 12th and 22d of November, a number of the nets were not lifted for several days. One firm at Put-in Bay took out 11 tons of herring from their seven nets on the 16th of November and left several tons in them. The next day the nets were full again, but the dealers at Sandusky sent word that they would only take a limited quantity each day. This firm estimate their loss from lack of a market for all their catch at $1,000. Five tons per day was not an uncommon catch, and Mr. Bower says that some claimed to have taken 10 tons from one net in a single day's fishing. At Kelley's Island alone between 25 and 30 tons of herring were dumped overboard or allowed to escape for lack of a market. One firm made hasty arrangements for salting and took care of most of their surplus in this way. These were the first fish that had been salted here for a number of years.

Description of fykes.—The fyke-nets of the island region are mostly made of second-hand twine. The fyke proper, or pot, is 20 feet long, the hearts are 48 feet long, and the leaders, from 150 to 300 feet long. The size of the mesh is $4\frac{1}{2}$ inches in the leader, 4 inches in the hearts, and $2\frac{1}{2}$ inches in the pot.

Catfish hooking around the islands.—A large number of men and boys on the islands take catfish with set-lines in 15 to 30 feet of water, between June 1 and September 1, or, in some localities, from May 15 till late in October. Some of them are professional fishermen, while others are farmers living along the coast. There are two varieties of catfish caught, known to the fishermen as blue or black catfish and yellow catfish. The blue species varies in weight from half a pound to 40 pounds, but generally weighs between 5 and 15 pounds. The yellow fish weigh from 4 to 6 pounds, or, in occasional instances, 8 or 10 pounds. The fishermen consider the yellow variety more palatable than the blue, though they bring the same price in market. The catfish caught in the pound-nets in the spring and fall are shipped in the "rough" or undressed state to the dealers, who have them dressed before supplying them to the retail trade; but those taken in summer with hook and line are dressed by the fishermen, losing about half of their weight in the process. This species is always in demand and brings a good price.

Species taken in island region.—Herring are much more abundant now than in the early days of the fisheries, but all other kinds of fish have gradually decreased in numbers. Mr. Rehburg says that before 1860 he has sometimes taken three thousand six hundred black bass in one pound-net in a day, and 4 tons of whitefish in one net in a single night. Sturgeon were little esteemed, and in 1858 were sold for 10 cents apiece. In 1862 herring sold for 25 cents per hundred weight. White bass were at one time very abundant around the islands, appearing, as the old fishermen say, in enormous schools. In fact they were the most abundant species fifty or sixty years ago, and Mr. J. H. Klippart says they were caught in immense quantities between 1853 and 1860, when they were sold for $6\frac{1}{4}$ cents a hundred pounds. As many as 10 tons of them have been thrown overboard at one time for lack of a purchaser. Since 1860 they have been growing scarcer every year, and only a few are now taken. This species and the muskellunge have decreased more rapidly than any others. Professor Kirtland stated in 1838, in a report on the zoölogy of Ohio, that at that time whitefish were not sufficiently abundant in this part of Lake Erie to be of commercial importance. According to Mr. Klippart they were so exceedingly abundant in 1849 as to sell in the Cleveland market for $5.50 per barrel of 200 pounds, including barrel. At that date 8 tons of them were sometimes taken from a pound net at a single drawing. It is probable that they really have been abundant in the lake from a remote period, for there is a tradition that even about the middle of the last century the Wyandotte and other Indians made a practice of resorting to the shore in the

vicinity of Sandusky Bay for the purpose of gathering the whitefish which were thrown on the beaches by northeast storms. Prior to 1855 no whitefish were caught by the white settlers in spring, but since that time they have been taken in large numbers at that season. The whitefish secured near the shore are said never to be so large as those caught farther out, but those from the vicinity of the islands are as large as any taken in the lake. Very few lake trout are ever seen west of Huron. Black-bass fishing is very good around the islands in the spring and fall, and anglers come there every season to enjoy this sport, but the catch is much less than in early years. In 1850 Mr. Andrew Cameron, who was fishing for black bass for profit, caught in the first three days, with the assistance of his wife and a young man, twelve hundred of this species, weighing from half a pound to 5 pounds each, and afterwards caught on one occasion 300 pounds in two hours. Such catches are of course unheard of at the present time.

The catch of the islands is classified as follows in shipping to the dealers at Sandusky:

(1) *Hard fish;* includes whitefish, pickerel, black bass, grass pike, muskellunge, large blue pike, and large rock bass.

(2) *Herring.*

(3) *Sturgeon.*

(4) *Catfish.*

(5) *Soft fish;* includes saugers, blue pike, very small pickerel, sunfish, and rock bass.

(6) *Miscellaneous*, or *trash;* includes suckers, redhorse, mullets, etc.

(7) *Perch.*

All are sold by weight except sturgeon, and rank, according to their value per pound, in the following order: Hard fish, catfish, soft fish, herring, and trash. Sturgeon sold for $1 each in 1885.

Most of the island catch is sold on contract. The contract price of whitefish during the fall of 1885 was 5 to 5½ cents per pound, less the steamer freightage, and that of herring was 75 cents per hundredweight, less the freight. The herring were bought at this price by the dealers and sold again at $1.25 per hundred. The price of herring was lower than usual on account of the enormous run of that species. On November 17, 1885, the steamer *Jay Cooke* brought to Sandusky from the islands 7 tons of whitefish and over 100 tons of herring, most of the latter from Kelley's Island. On the same day the steamer *Eagle* brought in about 80 tons of herring from Put-in Bay and Middle Bass islands, leaving 20 or 25 tons behind; and the steamer *Ferris* landed a full load from Catawba Island. During the week ending November, from 50 to 100 tons of herring were dumped into Sandusky Bay.

The fish are placed for transportation in open boxes furnished by the freighting steamers. These boxes hold about 180 pounds of herring or 200 pounds of whitefish each, and are provided with rope handles for convenience in handling. The fish are weighed on the boat just before unloading.

Sandusky Bay.—Sandusky Bay is about 5 miles broad and extends inland 16 miles in a southeasterly direction. It is very shallow and its greatest depth in the channels which have been dredged for navigation is only 20 feet. Its fisheries are of considerable importance. Nearly a thousand fyke-nets and small pound-nets are fished in its waters, and there is some seining in winter in its western part. It is claimed that the pioneer pound-net of western Lake Erie was set on the southeast side of Johnson's Island within the mouth of the bay.

The principal kinds of fish taken are perch, saugers, sunfish, pickerel, bass, bull-heads, grass-pike, suckers, red-horse, and mullet. A number of whitefish are said to have been taken in a seine near Mixer's Point, in 1846, but none have been found in the bay since that time. The catch of Sandusky Bay, like that of all the island region, is sent fresh to Sandusky, except a portion of the winter yield, which goes to Port Clinton.

Sandusky.—The city of Sandusky is located just within the entrance of Sandusky Bay, on its south side, back of Cedar Point. It is the largest market for fresh-water fish in the world. Its location is very favorable, and, besides controlling the fisheries of Sandusky Bay and the islands, as well as those of the main shore between Port Clinton and Huron, it is the market for large quantities of fish that are taken in Canadian waters on the other side of the lake and at Pt. Pelée Island. It has a population of 22,000, of which the greater part are dependent upon the fisheries or the fish trade. All the methods of preparing and utilizing fishery products which occur on the Great Lakes are represented here in their most improved forms, with the exception of canning and the making of fertilizers. The latter business was carried on here for some years, but the factory was burned and has never been rebuilt.

The manufacture of fish packages is engaged in, in connection with general cooperage, by two Sandusky firms, who supply all the fish-dealers of the city and many of those at other points. About $70,000 are invested in the business and over a hundred men are steadily employed.

The approximate yearly output of packages for salt fish is 334,000 kits (graded to hold 15 and 20 pounds), worth $53,440; 105,300 quarter-barrels, worth $26,578, and 85,700 half barrels, worth $35,394. To these should be added 21,000 barrels (each being of large size—a "barrel and a half"), for fresh fish, worth $5,030.

In addition to the packages manufactured expressly for fish, from 12,000 to 15,000 empty sugar barrels are bought from grocerymen and vintners to be used in shipping fresh fish from Sandusky.

Most of the boats used in the island region are built at Sandusky or by Sandusky boat carpenters, who go to the fishing regions and there construct the boats.*

* About 1887 a new type of pound-net boat was introduced in this region. It has a comparatively narrow, flat bottom, round sides, is carvel built, and has a long, sharp bow like that of other boats, but has no skag, since the latter would interfere with entering the cribs. I had the opportunity to see and examine this type of boat in the autumn of 1888, when I visited Sandusky and Put-in-Bay.—J. W. COLLINS.

In 1830 the only fish-dealers in the place were Messrs. J. and J. Hollister and William Townsend. At that time all the fishing of the vicinity was confined within the limits of Sandusky Bay, and, apart from a little line-fishing, was done with seines 30 to 50 fathoms long; and the fishing season did not extend beyond the months of April, May, and June. The white bass, pike, grass pike, and catfish, which constituted the bulk of the catch, were salted on the fishing grounds by those who caught them; black bass and muscallonge were also very abundant, and were sold fresh.

In 1847, Mr. Charles Higgins began shipping fresh fish in small quantities to Cincinnati and the intervening towns, and after the introduction of pound-nets others went into the business.

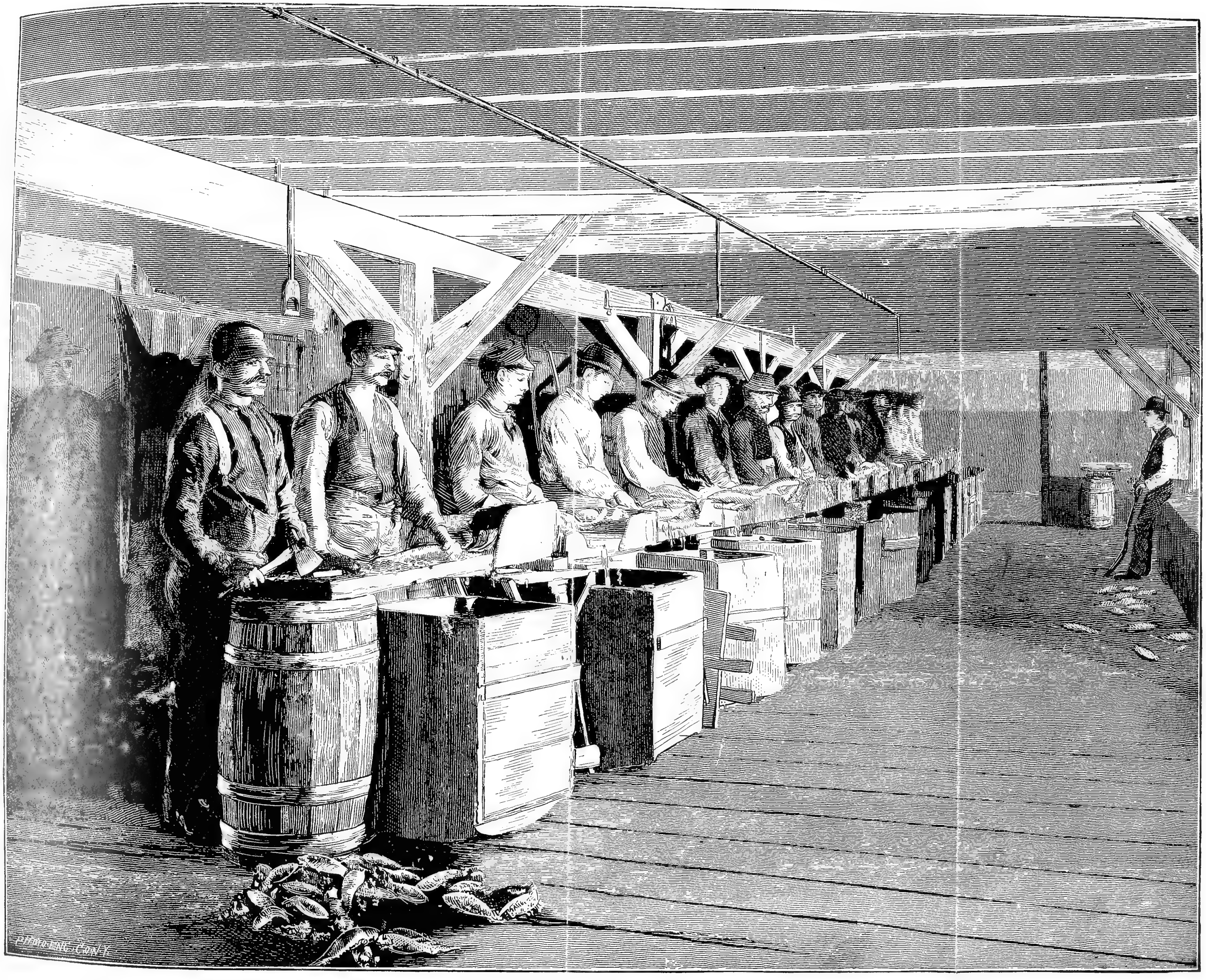
Between 1870 and 1875 the trade of Sandusky was in the hands of nine firms, the extent of whose operations in 1870–'72 is shown by the following figures published by Mr. Klippart:

Year.	Spring trade.	Fall trade.
	Pounds.	*Pounds.*
1870	3, 024, 370	7, 560, 550
1871	2, 897, 365	4, 666, 580
1872	1, 813, 055	5, 585, 885
Average for three years	2, 578, 263	5, 937, 672

Three of the most prominent firms began business in 1855, 1856, and 1857, respectively. One of the largest firms has since its origin shipped over 50,000,000 pounds of fish. Two started in 1877 and two others in 1880. The other four firms had a less extensive business. Some operate their own fishing apparatus and hire the fishermen, others buy much of their fish from independent fishermen, to whom they in many cases, however, make advances of material, etc.

Four steamers are owned by as many different dealers; two are fitted with gill-nets for fishing, and the others are used simply in collecting fish.

Two firms devote their entire attention to sturgeon and herring. Little use was made of sturgeon in this region until Simon Schacht came here in 1866 and went into business. Since that time the value of the species has been more and more appreciated, and 2,000,000 or 3,000,000 pounds are now handled annually. One of the firms purchases at least 50,000 or 60,000 sturgeon a year. At Erie, Pennsylvania, and at other places whence are received regular supplies of sturgeon, several men are kept at work dressing fish. The lake sturgeon which are used range from 30 to 150 pounds in weight, but sometimes salt-water sturgeon are received from Georgia, which often weigh as much as 400 or 500 pounds apiece. Some of the sturgeon are sold fresh, and some frozen, but most of them are smoked, as are also all the herring handled by the firm. The smoked products are shipped to all parts of Ohio and to adjoining states, and are destined to take a high place in the public favor.



INTERIOR OF FISH-PACKING ESTABLISHMENT AT SANDUSKY. FISH-CLEANING GANG AT WORK.

From a photograph.

Many thousand pounds of sturgeon roe are now annually spiced and pickled as caviare, and large quantities of isinglass are made from the sounds or air-bladders. A large portion of both these products is sent to Germany. The yearly exportation is about 1,000 kegs of caviare and 3,000 pounds of isinglass. Over 25 barrels of oil are tried out yearly from the offal of the sturgeon by the two firms interested.

Before productive fisheries existed at Sandusky, fish were brought from Lake Huron and the Detroit River to Cleveland and other lake ports, whence they were shipped to the towns in the interior. After the opening of the Ohio and Miami canals, the shipments of fish formed a considerable item in their commerce, but the introduction of railways rapidly diverted to them this growing business and facilitated its expansion by extending greatly the distance to which fresh fish could be shipped upon ice in good condition. Mr. Klippart has compiled from the reports of the canal commissioners and board of public works the following table of receipts of lake fish at Sandusky by canal from the opening of the Ohio Canal, in 1832, to the time the canals were placed in the hands of the lessees, in 1861:

Shipments of lake fish by canal from the places named.

Years.	Cleveland.	Toledo.	Maumee City.	Total.	Years.	Cleveland.	Toledo.	Maumee City.	Total.
	Barrels.	*Barrels.*	*Barrels.*	*Barrels.*		*Barrels.*	*Barrels.*	*Barrels.*	*Barrels.*
1832	7,661			7,661	1849	$12,899\frac{1}{2}$	2,222	2,671	$17,792\frac{1}{2}$
1833	4,033			4,033	1850	18,211	6,864	3,241	28,316
1834	4,024			4,024	1851	19,942	8,553	4,137	32,632
1835	6,136			6,136	1852	18,148	7,725	3,828	29,701
1836	4,082			4,082	1853	18,260	11,063	5,187	34,510
1837	6,248			6,248	1854	10,325	6,619	3,121	20,065
1838	7,504			7,504	1855	5,378	2,804	360	8,542
1839	8,851			8,851	1856	6,268	3,390	1,535	11,193
1840	9,061		17	9,078	1857	4,645	1,641	2,219	8,505
1841	9,309		190	9,499	1858	3,691	2,173	1,449	7,313
1842	6,274		2	6,276	1859	3,617	1,070	939	5,626
1843	6,689	342	419	7,450	1860	2,346	2,679	691	5,716
1844	7,900	317		8,217					
1845	10,400	2,186	430	13,016	Total	$250,541\frac{1}{2}$	72,955	35,102	$358,598\frac{1}{2}$
1846	8,884	4,303	1,367	14,554					
1847	10,044	4,617	1,106	15,767					
1848	9,711	4,387	2,193	16,291	Annual average	$8,639\frac{9}{25}$	$4,054\frac{1}{6}$	$1,755\frac{1}{10}$	12,366

At present every county in the State, with scarcely a single exception, can be reached from Toledo, Sandusky, or Cleveland within twelve hours, so that the fish are brought to the very door of the consumer in a perfectly fresh state.

In the early history of the fresh-fish trade, the shipping season covered only a few weeks in the spring and fall, and during that time a single firm would handle an average of 30 or 40 tons daily. By the use of large quantities of ice the dealers are now able to distribute the trade more evenly throughout the year. Several firms receive shipments of fish from the upper lakes, packed in ice, which serve to keep the market stocked at times when a local supply is not obtainable. The introduction of freezing houses, in which the fish can be frozen in the fall and

held for distribution over the whole country in winter and spring, has also facilitated very much the equalization of the supply, and to the same extent has prevented such marked fluctuations in price as otherwise might occur to the great injury of the fisheries. The first to carry on the freezing process in Sandusky to any great extent was Mr. Ferdinand Geissdorf, who was engaged in the fish trade there from 1855 to 1868. For a long time he owned the exclusive right to the Davis patent. Since the last-mentioned date the business of freezing fish has increased very much at Sandusky, and in 1885 several firms were provided with freezing houses. Some of these have a freezing capacity of 10 to 20 tons of fish per day, and they will each hold from 300 to 375 tons of frozen fish. Some of the firms own large ice-houses, in which is stored the ice used in the freezers and for packing unfrozen fish for shipment. One of these has a storage capacity of 1,500 tons of ice. Much of the frozen fish is shipped to the principal dealers in the East.

The following table shows the quantity of fish handled by the wholesale fish dealers of Sandusky in 1885, during certain times in which year the daily receipts from the fisheries in the vicinity of Sandusky amounted to from 500 to 700 tons of fish.

Wholesale fish trade of Sandusky, Ohio, in 1885.

Species.	Fresh.	Frozen.	Salted.	Smoked.	Secondary products.	Total weight.	Total value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Bass	300,000					300,000	$16,500
Blue pike	14,200	117,250	45,000			176,450	6,750
Catfish and bullheads	834,170					834,170	21,000
Grass pike and muskellunge	77,000	35,000				112,000	7,350
Herring	4,378,000	2,270,000	3,930,000	220,000		10,798,000	233,700
Perch	700,000	30,000				730,000	7,000
Saugers	1,357,370	446,350	1,931,000			3,734,720	89,900
Sturgeon flesh	280,000	160,000		2,110,000		2,550,000	179,800
Sturgeon caviare					156,575	156,575	21,150
Sturgeon isinglass					3,250	3,250	4,875
Sturgeon oil					*3,485	*3,485	1,325
Wall-eyed pike (called pickerel)	370,000	25,900				395,900	23,400
Whitefish	346,300	296,000				642,300	46,000
Other fish	528,000	9,500	20,000			557,500	3,550
Total	9,185,040	3,390,000	5,926,000	2,330,000	159,825	20,990,865	662,300

* Gallons, not included in the total.

Statistics.—The total number of fishermen between Port Clinton and Huron, in 1885, not including those ports, but including Bass Islands, Kelley's Island, and Sandusky, was 590, and the number of shoresmen and preparators was 232; the directly dependent population being no less than 2,102. Eight steamers, worth $33,500, were engaged in fishing, and two, worth $13,000, in collecting fish. The regular passenger and freight steamers which ply between Sandusky, the islands, and other lake ports, and transport large quantities of fish, are not included in this enumeration. Seven sail-boats were used in collecting and 122 in tending pound-nets, their value being $21,995. There were, in addition,

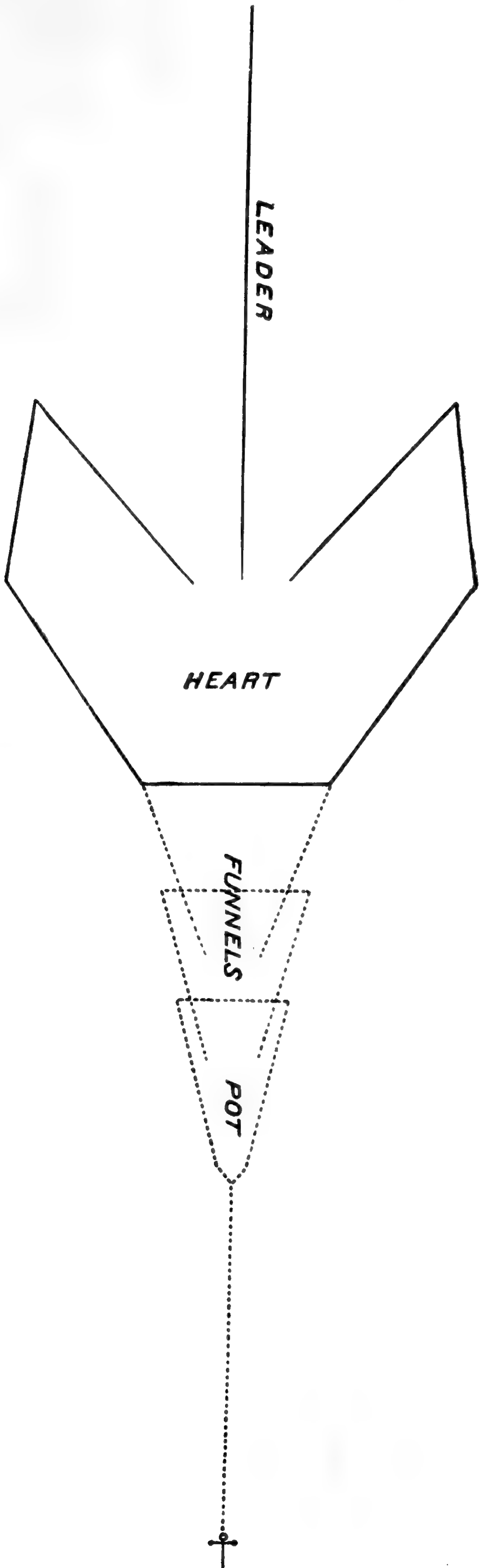


DIAGRAM OF LAKE ERIE FYKE-NET.

4 seine-boats, 54 scows, and 243 small row-boats, with a combined value of $20,932. The amount and value of the apparatus of capture were as follows: 5,059 gill-nets for whitefish and trout, worth $15,598; 336 other gill-nets, $1,428; 359 pound-nets, $144,870; 5 seines, $875; 100 traps or "baby pounds," $7,500; 893 fyke-nets, $57,830; 70 set-lines, with 47,500 hooks, $715; besides hand-lines and spears to the value of about $75. The cash capital of the dealers amounted to $138,000, that invested in wharves and buildings, $183,475, and that in fixtures and accessories, including fish-cars, $33,218.

The products consisted of 2,155,000 pounds of saugers, 8,400,000 pounds of herring, 1,100,000 pounds of catfish, 565,000 pounds of whitefish, 508,500 pounds of wall-eyed pike, 450,000 pounds of black bass, 265,400 pounds of blue pike, 190,000 pounds of sturgeon, 155,000 pounds of grass pike and muskellunge, and 1,375,000 pounds of other species, mostly perch, sunfish, rock-bass, suckers, red-horse, and mullet. The total value of these products, at the prices received by the fishermen, was $234,800, the total weight amounting to 15,163,900 pounds.

90. HURON, ERIE COUNTY, OHIO.

General.—Huron, the first fishing center east of Sandusky, is situated on the Huron River, which affords a fine harbor with sufficient depth of water to admit the largest lake craft. In 1885 it had about 1,200 inhabitants, the greater part of whom were dependent directly or indirectly on the fisheries.

Pound-net fishery.—Pound-nets were set here very soon after their introduction into Lake Erie, and the fishing is still principally with this form of apparatus. Between Cedar Point at the mouth of Sandusky Bay and at Vermillion, a distance of 18 miles, there were fished in 1885 about 190 pound-nets. Some of these were owned at Sandusky and Vermillion, but one hundred and eleven belonged to Huron firms. The Huron fishermen set their nets in strings of eight to twenty-two, several different fishermen having nets in the same string. The depth of the water in which the bowls of the pound-nets are set varies from 20 to 45 feet, averaging 35 feet.

The pound-nets are operated both in spring and fall. The fall run of whitefish is short on this shore, the good fishing lasting but a few days while they are passing up to the spawning grounds. The nets are all taken up before the beginning of the return run, which takes place in early winter.

Other fisheries.—A few gill-nets were fished at this place for saugers in 1884, for the first time, and since then several crews have engaged in this fishery each spring. There is also some cat-fish-fishing with set-lines.

Trade.—The pound-net fisheries are entirely in the hands of 8 firms, who have from three to thirty-five nets each. Seven of these are dealers,

as well as fishermen, and ship their catch, together with such additional quantities as they are able to purchase in the vicinity, to points all over the country. Several of them have large and well-appointed establishments fully equipped for freezing, icing, and salting. Such sturgeon as are caught here are usually sent to the smoke-houses at Sandusky.

Large quantities of salt fish are handled at Huron; in addition to those obained locally, important consignments are received from other parts of Lake Erie, and also from the other lakes.

The following table shows the extent of fish trade of Huron in 1885:

Wholesale fish trade of Huron, Ohio, in 1885.

Species.	Fresh.	Frozen.	Salted.	Total.	Value at price received by dealers.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Bass	23, 500			23, 500	$1, 420
Blue pike	95, 000	107, 000		202, 000	7, 225
Catfish	14, 400			14. 400	870
Grass pike	30, 000			30, 000	1, 500
Herring	590, 000	178, 000	371, 000	1, 139, 000	25, 600
Perch	48, 200	11, 000		59, 200	670
Saugers	111, 000	105, 000	260, 000	476, 000	12, 970
Sturgeon	12, 000			12, 000	480
Wall-eyed pike	35, 000			35, 000	1, 750
Whitefish	28, 500			28, 500	1, 750
Other kinds	93, 000	18, 000		111, 000	1, 740
Total	1, 080, 600	419, 000	631, 000	2, 130, 600	55, 957

A great many of the fish caught along the shore between Sandusky and Cleveland are taken by peddlers into the interior. The demand is good, as it is a thickly settled and prosperous farming region, with numerous towns and villages.

Statistics.—The fisheries of Huron gave employment in 1885 to 62 fishermen and 16 shoresmen, and the wholesale fish trade to 54 other persons; while the total number of people directly dependent upon these for their support was 253.

Three gill-net boats, 19 pound-net boats, 6 scows, and 18 small row-boats that were employed, had a total value of $8,170. There were 180 gill-nets, 111 pound-nets, and set-lines with 6,000 hooks, the value of these apparatus of capture amounting to $53,115. There were invested in wharves and buildings $42,450, in fixtures and accessories $6,335, and as working capital $43,100.

The products amounted to 2,233,790 pounds, divided as follows: Herring, 1,347,500 pounds; saugers, 287,100 pounds; blue pike, 288,100 pounds; catfish, 83,900 pounds; whitefish, 42,200 pounds; sturgeon, 41,750 pounds; "hard fish," including wall-eyed pike, grass pike, bass, and muskellunge, 44,040 pounds; perch, 55,500 pounds; and other fish, 43,700 pounds. The total amount received by the fishermen for their catch was $36,630.

91. VERMILLION, ERIE COUNTY, OHIO.

The town.—The only place in Erie County east of Huron where any fisheries are carried on is Vermillion, 10 miles distant, near the boundary line of Lorain County. Two railroads pass through the town; and Vermillion River, at the mouth of which it is situated, furnishes a good harbor, so that it has some lake commerce. The population in 1885 was 1,200, and the fisheries were the most important industry.

The fisheries.—Twenty-three pound-nets are owned by Vermillion firms and set in seven strings, all within 5 miles of the county line. A score of men fish for catfish, with set-lines, working in separate boats and having about a thousand hooks each. Three steamers and three boats' crews fish for saugers in early spring, with gill-nets, the steamers with one hundred and fifty or two hundred nets each, and the small boats with from ten to fifty nets. One of the steamers also goes to the Bass Islands in the late fall to fish with gill-nets for whitefish, and two additional sail-boat crews, of two men each, engage in the same fishery. The nets used are 5 feet deep and 10 to 18 rods long, averaging 15 rods.

Trade.—There are three firms of fish dealers at Vermillion, by whom all the pound-nets are owned. All of them salt considerable quantities of fish, principally herring; and one of them has the only freezing establishment in the town. There is, also, a cooper-shop, where are manufactured 2,000 whole barrels and 500 half-barrels per annum. A building costing $500 is used for this purpose, and one man is kept regularly employed. The greater portion of the yield of the fisheries of this town is sold to the three dealers, by whom it is shipped directly to the retail trade in different parts of the country.

Statistics.—The number of fishermen at Vermillion in 1885 was 61; of men employed in handling and preparing fish, 15; and of persons dependent upon these for their support, about 160. Besides the steamers and gill-net boats there were 4 scows, 4 pound-net sail-boats, and 30 small row-boats, the total value of the vessels and boats amounting to $9,385. Seven hundred and eighty-five gill-nets, 23 pound-nets, and 20,000 set-line hooks constituted the apparatus of capture, with a value of $14,820. The working capital of the dealers was $4,500; that invested in wharves and buildings $8,935, and that in fixtures and accessories $1,410. There were caught 640,000 pounds of herring, 212,000 pounds of saugers, 177,000 pounds of blue pike, 43,300 pounds of whitefish, 34,500 pounds of sturgeon, 51,000 pounds of catfish, 30,000 pounds of perch, 14,800 pounds of bass, wall-eyed pike, grass pike, and muskellunge, and 23,000 pounds of miscellaneous fish, mostly the little-esteemed varieties called "trash." The total quantity was 1,225,600 pounds, with a value to the fishermen of about $23,000.

92. LORAIN AND CUYAHOGA COUNTIES, OHIO.

General observations.—The fisheries of Lorain County are not very important, and are naturally grouped with those of Cuyahoga County, as they are all tributary to the city of Cleveland and largely controlled by the dealers there.

There are no villages or settlements between Vermillion and Lorain, although the region is thickly settled.

Pound-net fishery.—Fishing is carried on principally with pound-nets operated or controlled by well-to-do farmers whose lands border the lake shore. In 1885 there were seven stands, or stations, with fifty-nine pound-nets, which were set in from 24 to 45 feet of water, in strings of two to six nets each. The first fishery was 4 miles east of Vermillion and 6 miles west of Lorain; the last of the seven was 2 miles farther east. The owners of the five fisheries nearest the county line resided near Brownhelm Station; the other two at North Amherst and Lorain, respectively.

The fishery at Beaver Creek was the only one of the seven at which there was a harbor of any kind. At all others the fish-boats were hauled on the beach alongside the fish-house before unloading by means of a winch turned by hand-power.

Mr. Leidheiser, who began fishing pound-nets here in 1858, states that the first one between Lorain and Vermillion was set in 1856.

Other fisheries.—There were two gill-net crews from Brownhelm Station, one fishing fourteen nets in the fall, and the other forty nets both in fall and spring. The gill-nets used here were 25 fathoms long and 5½ feet deep. One of the crews employed a steamer and the other a sail-boat. There was also a very little catfish fishing with set lines.

Abundance of whitefish.—Whitefish are not so abundant here as formerly, but a considerably greater number were taken in the spring of 1885 than in 1884, or during the two or three years immediately preceding.

Disposition of products.—Each of the fishery owners has a good fish-house for icing and salting; but there is no freezing done. The fish are hauled for shipment to one of the two railroads which here run nearly parallel with the lake shore from 1 to 3 miles back.

Caviare.—A man at the North Amherst fishery purchased sturgeon roe from other fisheries between Lorain and Vermillion for the purpose of making caviare. He paid at the rate of 10 cents for the roe of each fish. Twenty packages were prepared in 1884 and thirty in 1885, containing 140 pounds each.

The town of Lorain.—Lorain is situated on the Black River, which furnishes a good harbor, admitting the largest craft, and its lake commerce is extensive, while two railroads furnish excellent shipping facilities. The fisheries, however, are of comparatively little importance. Two firms fish three pound-nets each, and there is a single crew of gill-net fishermen with twenty nets, 45 fathoms long by 5½ feet deep. The gill-net crew goes to North Bass Island in the late fall to fish for white-

fish, returning to Lorain after the close of the season. A few years ago there was some gill-net fishing from Lorain, but it has been discontinued. The only other fishing in the town is for catfish with hook and line through the ice in winter. One man has a set-line 3 miles long with one thousand six hundred hooks.

From Lorain to the boundary between Lorain and Cuyahoga Counties the bottom is too rocky to allow the staking of pound-nets, and there is no fishing of any description.

Statistics of Lorain County.—There were 59 professional fishermen in Lorain County in 1885, either fishing their own apparatus or hired for monthly wages, and more than a dozen others worked occasionally by the day as extra hands at the different fisheries during a heavy run of fish. The value of shore property and minor apparatus was about $12,000. The products of the fisheries were valued at $31,000, representing about 1,490,000 pounds of fresh fish and 520,000 pounds of salt fish. Half of the catch in quantity was herring, one-fourth blue pike, 153,000 pounds saugers, 50,000 pounds whitefish, and the rest perch, catfish, miscellaneous, sturgeon, wall-eyed pike, bass, grass-pike, and muskellunge.

Trade and preparation, Lorain County.—The only species salted are herring and blue pike. The fresh fish are usually sold to peddlers or to the retail trade in the interior, only the surplus going to the wholesale dealers, as their prices are 25 to 75 per cent. lower than those paid by retailers; but those which are salted are shipped under contract to the dealers at Cleveland, who furnish salt and packages and pay $1.40 per barrel for the fish. The barrels are really half-barrels, containing 100 pounds each. Each fishery supplies from one to four peddlers regularly throughout the fishing season. Mr. Wittmer, of Brownhelm Station, estimates that there are twenty-five of these peddlers from Vermillion to Detroit Bay, inclusive.

Dover Bay.—The first fisheries east of Lorain are in Dover Bay, 15 miles away, within the limits of Cuyahoga County, and 12 miles west of Cleveland. On account of the richness of the soil the region is thickly settled with farmers and grape-culturists. All of the fishing is with pound-nets, of which there were thirty in 1885, set in eleven strings within a strip of coast 3 miles long, beginning near the county line. The shortness of the strings is made necessary by the depth of the water. Some of the outside ones were from 40 to 46 feet deep, the others ranging from 20 to 40 feet. They were owned by three firms of farmers whose lands run down to the shore. One of them belongs at Dover, one at West Dover, and one at North Dover.

Pound-nets were first set in this bay in 1858. For some years prior to that event there had been some fishing with haul-seines, but it was of little importance and has since been entirely abandoned.

There are no harbors along this shore, and the fish-boats have to be hauled on the beach with a winch.

Among the principal varieties of fish taken are herring, blue pike, "pickerel," saugers, and whitefish. The last-named species is not nearly so abundant in Dover Bay as it was ten or twelve years ago, but it is claimed that the spring catch was much better in 1885 than it had been for three or four years.

The fishermen have large and well-appointed fish-houses where they prepare their fish for market. A portion of the catch is sold fresh to peddlers and the retail trade, and the rest is salted and shipped to the Cleveland dealers. The fish for shipment are hauled by wagon to the hamlets of Dover, West Dover, and North Dover, 1 to 2 miles distant on the railroad. The fresh fish are shipped with ice in barrels containing 200 pounds each. Part of the herring catch goes to the smoke-houses at Cleveland.

Rocky River.—A little farther to the eastward and 7 miles west of Cleveland is Rocky River, near the mouth of which boats of small size find a good harbor. Two firms, one belonging at Rocky River and the other at West Dover, own strings of pound-nets, numbering ten in all. The products are all shipped to Cleveland, most of them fresh, but some of the herring and blue pike are salted. The West Dover firm brought out a new steamer in the fall of 1885 to engage in gill-net fishing from Rocky River, Cleveland, and other points.

The city of Cleveland.—There are no fisheries between Rocky River and the Cuyahoga River, at the mouth of which the important city of Cleveland is situated. The river furnishes a good harbor, admitting all lake craft, and the commerce by water is large. The population of Cleveland is about 225,000, and the chief industries are manufacturing, coal and lumber dealing, oil refining, and the usual city trade. Compared with the other business of the place the fisheries are unimportant.

Fisheries of the city.—Cleveland is practically the dividing line between the pound-net and gill-net fisheries of Lake Erie. The pound-net fishery is predominant in that part of the lake west of Cleveland, while the gill-net is the principal form of apparatus in the eastern section of the lake. There are no pound-nets between Rocky River and Euclid, near the boundary of Lake County. The fishing from Cleveland is with gill-nets and lines. The best authorities state that gill-nets were first used here in 1877. Three steamers and three sail-boats owned at Cleveland are employed in the gill-net fisheries. They fish in spring and fall with nets 214 to 330 feet long, 5 feet deep, and 3 to 3½ inches in the mesh; and their catch is principally blue pike, herring, and perch. Blue pike are exceedingly abundant in the bay, but very few whitefish are taken. Over fifteen hundred gill-nets in all are fished by these six crews.

Beside the fishermen living at Cleveland the year round, several steamers and about a dozen sail-boats from other ports fish from there in spring for blue pike.

There is a good deal of fishing with hook and line through the ice in winter by all classes, but especially by the poorer people, many of

whom depend chiefly upon this for a livelihood. The catch is principally blue pike, saugers, and herring.

One large fyke-net was set in the lake, near Cleveland, during the fall of 1885, as an experiment. It is the first one ever set in this part of the lake.

There is no fishing of any kind in summer.

Fish trade of Cleveland, past and present.—Before there were any railroads in this region Cleveland was an important receiving and distributing depot for the fishery products of the Detroit River and the upper lakes. Shipments were made by land and consisted entirely of salted fish.

At the present time the importance of the city as a fish market is rapidly growing. A prominent dealer is of the opinion that the quantity handled in 1885 was three times as great as in 1880.

There are three dealers at Cleveland who buy directly from the fishermen and handle great quantities of fish brought from the opposite Canadian shore—the north shore of the lake—and from the upper lakes. Two of them have large freezers, and one has an extensive canning establishment, the only one on Lake Erie. The owners of the cannery refused to give any information regarding their products, and the figures relating to it are therefore estimates based upon such information on the subject as could be obtained from other sources, and probably vary somewhat from the actual facts. The prepared product of this establishment is chiefly herring, sold under the brand of "canned salmon." This firm owns a collecting steamer, which makes three trips per week to Canadian ports during the fall months for herring and other products of the Canadian fisheries.

There are seven small establishments in Cleveland where herring and sturgeon are smoked, chiefly for the city trade. A great many of the sturgeon come from Canadian waters. A score of people find employment in this business, and about $4,000 are invested in it.

The following table shows the quantity and value of fishery products handled by the Cleveland dealers in 1885. The greater part of the whitefish and trout were from Lakes Superior and Huron, but the rest of the fish were from Lake Erie.

Wholesale fish trade of Cleveland in 1885.

Species.	Fresh.	Frozen.	Salted.	Canned.*	Smoked.*	Total.	Value at prices received by dealers.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	
Bass	10,000					10,000	$620
Blue pike	970,000	300,000	430,000			1,700,000	39,200
Catfish and bull-heads	62,000					62,000	2,500
Grass pike and muskellunge	13,000	2,000				15,000	700
Herring	790,000	310,000	1,275,000	100,000	80,000	2,555,000	47,400
Mullets, lawyers, and other fish	48,000	4,000				52,000	500
Perch	66,000	11,000				77,000	835
Pickerel (*i. e.*, wall-eyed pike)	53,000	4,000				57,000	3,140
Saugers	111,000	45,000				156,000	3,200
Sturgeon flesh	36,000	14,000			100,000	150,000	8,850
Sturgeon caviare			4,200			4,200	500
Trout	180,000	27,000	135,000			342,000	36,450
Whitefish	195,000	44,000	120,000			359,000	21,220
Total	2,534,000	761,000	1,964,200	100,000	180,000	5,539,200	165,115

* Estimated.

This trade represents a capital of over $80,000, giving employment to between sixty and seventy people.

There are about a dozen retail fish-houses in Cleveland which handle the products both of lake and ocean fisheries. Three or four of them are large concerns that buy most of their lake supplies directly from the fishermen, but the others secure their supply from the wholesale dealers. Probably $40,000 is not too high an estimate for the portion of their capital which represents lake interests. This amount is of course not included in the above statistics, which are meant to cover only the strictly wholesale business.

Combined statistics of Lorain and Cuyahoga Counties.—There were in 1885 in Lorain and Cuyahoga Counties 137 professional and 45 semi-professional fishermen, representing, with the 70 persons employed by the wholesale fish business, a directly dependent population of 400. Five steamers, 5 gill-net boats, 29 pound-net boats, 17 scows for driving and pulling pound-net stakes, and 25 small row-boats were used, having a total value of considerably over $30,000. The number of gill-nets was 1,624, worth $5,000, and of pound-nets 108, valued at $43,300. The fykes and set-lines had a value of $500. Over $70,000 were invested in wharves and buildings, and $12,500 in fixtures and accessories, including fish-cars. The additional cash capital amounted to $23,000. The products were 5,059,000 pounds of fresh fish, with a value to the fishermen of $53,200, and 946,000 pounds of salt fish, valued at $13,250. Nearly four-fifths of the fresh fish were herring and blue pike, 122,000 pounds were whitefish, and more than a third of the rest saugers; the balance consisting of perch, catfish, sturgeon, wall-eyed pike, grass pike, bass, and several inferior varieties. The salt fish were nearly three-quarters herring and the remainder blue pike.

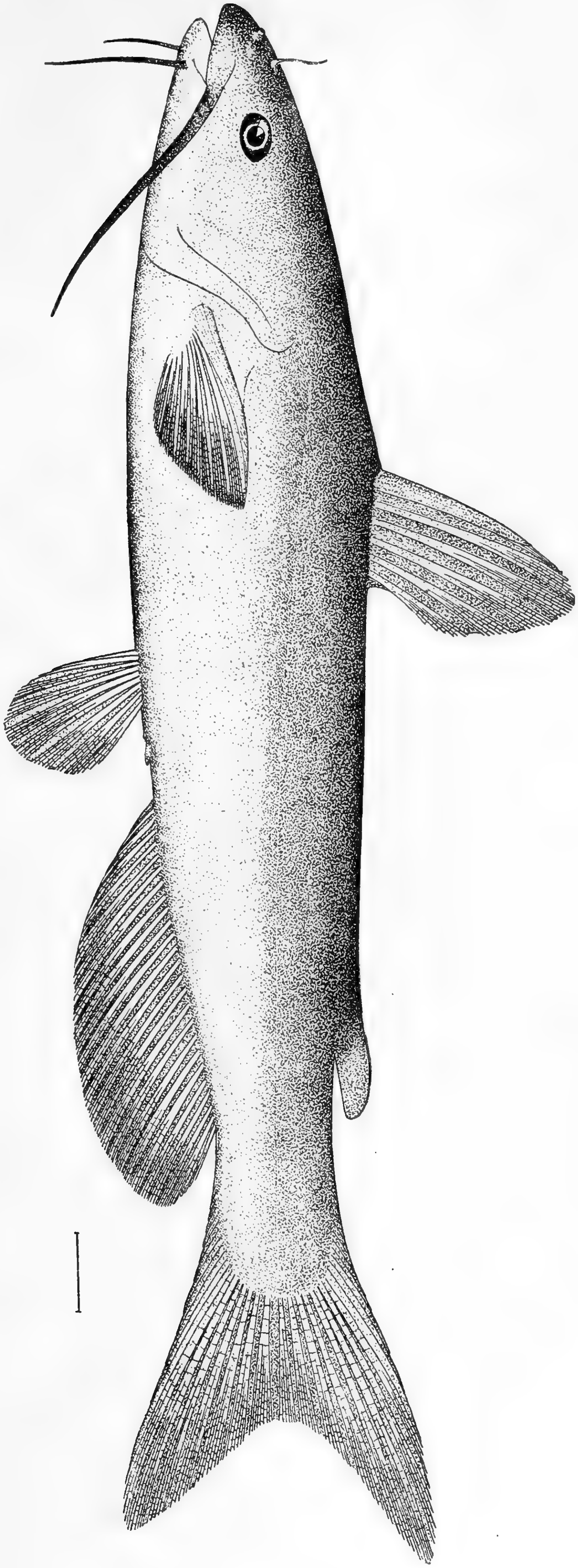
93. LAKE AND ASHTABULA COUNTIES, OHIO.

Enumeration of fishing stations.—The shores of the two eastern counties of Ohio are very even, without important indentations, and the only harbors are formed by the mouths of the Chagrin, Grand, Ashtabula, and Conneaut Rivers. The fisheries are carried on from the four towns located on these streams, namely, Willoughby, Fairport, Ashtabula, and Conneaut.

At Euclid, 12 miles east of Cleveland and 8 miles west of Willoughby, there is a string of pound-nets numbering three in spring and four in fall; but these are owned by a Cleveland firm and included in the statistics for Cuyahoga County.

Fisheries of Chagrin River.—The Chagrin River has not a sufficient depth of water to allow the entrance of vessels, but it forms a good harbor for fish boats. The town of Willoughby, with 1,200 inhabitants, is situated 3 miles from its mouth. Three pound-nets at this place are operated in the spring and four in the fall, on the lake shore just west of the mouth of the stream.

PLATE XXXV.



GREAT LAKE CATFISH (*Amiurus nigricans*).

The first pound-net was set here in the fall of 1861, but, as the catch was poor and the net was "blown out," no further experiments in that line were made until 1868, since which time several nets have been fished every season.

Some seining was carried on for a number of years prior to the introduction of pound-nets, but it was abandoned in 1869. No gill-nets have ever been fished from Chagrin River. About ten men take catfish with set-lines in summer, the last of them stopping soon after the middle of October. The products of their labor are sold to the pound-net firm, which disposes of them in the same way as those of its own fisheries.

It is stated by competent authority that whitefish were never abundant here, and that as many are now caught as at any time in the past. Sturgeon and blue pike are taken in large numbers at present, and they, with herring, comprise most of the catch.

The fish taken in the pound-nets are hauled to Willoughby by land. Two railroads pass through the place, and afford good facilities for shipping the catch, most of which is sent to the city of Cleveland, although four peddlers who ply their trade among the small towns of the interior during the whole of the fishing season obtain their supplies of fish at Willoughby. More than five-sixths of the fish are sold fresh, but a number of barrels of blue pike and herring are salted.

Fisheries of Grand River.—Grand River, 10 miles east of Willoughby, is one of the best harbors on the southern shore of Lake Erie, though its lake commerce is not very extensive. The fishing hamlet of Fairport, with a population of about 300, is situated at the mouth of the river, and the city of Painesville, with 6,000 inhabitants, 3 miles above.

Most of the fisheries of the river are controlled by two firms at Painesville, who carry on their fishing operations from Fairport, employing residents of that place to handle the nets and prepare the fish for shipment. Fairport is almost entirely dependent upon these fisheries. The independent fishermen, including two gill-net crews and all the catfish fishermen, sell their yield to the two firms for shipment.

Fourteen pound-nets are set in three strings in from 25 to 45 feet of water above and below the mouth of the river. One steamer and three sail-boats fish altogether a thousand gill-nets in early spring and late fall for whitefish and blue pike. These nets are 72 fathoms long and 5 feet deep, with cork floats and lead sinkers, and have a value of $5 to $5.50. There is some fyke-netting, and thirty persons fish for catfish with set-lines every summer.

Whitefish have never been very numerous in this locality, and a considerable portion of those caught in pound-nets, as well as those in the small-meshed gill-nets, weigh only a pound or less than a pound each. The seines that were fished here before the introduction of the other methods caught no whitefish, and the first of them were caught in pound-nets.

It is stated that the first pound-net in this vicinity was set in 1867. The gill-net fishing began in 1870.

The fishing has not varied much for a number of years, with the exception of such alternations of good and poor seasons as are supposed to be produced by the ordinary vicissitudes of wind and weather.

Painesville has three railroads, and the products of the Fairport fisheries are taken there for shipment.

Some of the whitefish and herring and large quantities of blue pike are frozen annually, and about one-third of the herring and a few blue pike are salted.

The catch of sturgeon in this vicinity is large, and a good deal of roe is made into caviare.

Fisheries of Ashtabula.—Along the coast between Fairport, Ohio, and Erie, Pennsylvania, a distance of 65 miles, the lake bottom is too rocky to allow the staking of pound-nets, which consequently are not used at all in that section. The boundary line between Lake and Ashtabula Counties runs half way between Fairport and Ashtabula. The latter is 26 miles east of Fairport, and is a growing city of 7,000 inhabitants. It is about 2 miles from the lake on Ashtabula Creek, which forms a good harbor for craft of all sizes, and the lake commerce is very large, while five railroads furnish abundant facilities for inland trade. Most of the lake traffic consists in the shipments of coal and the receipts of lumber and iron ore.

A little catfishing with set-lines is carried on at Ashtabula, and from points all along the neighboring shores, both in the direction of Fairport and of Erie; but, apart from this, the fisheries of the town consist only of one steamer fishing with gill-nets in spring and fall for whitefish and blue pike. A few years ago there were half a dozen gill-net boats here.

The fisheries of Conneaut.—The next fishing port is Conneaut, 13 miles to the eastward. It is situated on Conneaut Creek, 2 miles from its mouth. That river has a good depth of water, but it is only accessible to tugs and boats of small size, as a bar outside prevents the entrance of large vessels. The population of the town is 3,000, principally engaged in mercantile pursuits and in manufactures.

The fisheries are of little importance, and are carried on entirely with gill-nets and hooks. Three steamers and one sail-boat are used in fishing gill-nets in early spring and late fall for whitefish, blue pike, and herring. The gill-nets, of which there are nine hundred, have a length of 35 to 110 fathoms, averaging about 70 fathoms, and are 5 feet deep. Formerly, a 6-inch mesh was used, but now the mesh for whitefish is from 4 to 4½ inches, and the mesh for blue pike and herring is from 3 to 3½ inches. Some of the nets are rigged with corks and leads; others have wooden floats and stone sinkers. They are usually fished in about 80 feet of water. The gill-net fishing is followed at times from the mouth of the Conneaut Creek, but during certain portions of the season the steamers fish out of Dunkirk, Erie, and other ports.

The first fishing here with gill-nets was in 1867, and in 1870 the number of gill-net boats was as large as twelve or fifteen. Steamers were introduced into the fisheries in 1876.

Sturgeon spawn on the rocky bottom along this shore, and are very abundant here in June and July. During those months, farmers and others go out in small boats and grapple sturgeon by dragging hooks, with sharp-pointed prongs, along the bottom. In this way each boat frequently takes ten to fifteen sturgeon in three or four hours. Some sturgeon are taken in the gill-nets, but during the spawning season, when they are abundant, they usually tear the nets into shreds and most of them escape. Pound-nets would take large numbers of them here in those months, and these could be set, notwithstanding the rocky bottom, by ballasting instead of driving the stakes, as is done on the rugged coast of northern Maine. Strong, large-meshed gill-nets also, such as are used in the sturgeon fisheries of other portions of the Great Lakes and of the Delaware River, could doubtless be employed here to advantage.

Mr. Elijah Jones, an old fisherman of Conneaut, claims that whitefish also spawn on this rocky shore to some extent, basing his opinion principally on the fact that he has caught ripe fish here in November. He remarks that while all kinds of fish are less numerous here than formerly, the abundance of whitefish has increased since 1883.

The catfish fishing with set-lines is scattered all along this coast from Fairport to Elk River. The number of men engaged in it, in the summer of 1885, between Fairport and the state line of Pennsylvania, was about twenty-five, not including those at Fairport. Their stock averaged over $125 each.

Before the introduction of gill-netting, and for some time after that date, some seining was carried on by residents of Conneaut, but it has been wholly discontinued.

Statistics.—The total number of men employed in the fisheries of Lake and Ashtabula Counties in 1885 was 102 professional and 32 semiprofessional fishermen, and 31 shoresmen and preparators. The floating property consisted of 5 steamers and 2 steam scows, worth in all $14,800, 5 gill-net boats, $1,400, 1 scow, $200, and 16 small boats, $275. Over 2,000 gill-nets were used, with a total value of more than $10,000; 18 pound-nets, worth $7,800; and 12 fyke-nets, 65 set-lines, and a number of sturgeon grappling hooks, worth in all $1,200. The value of the shore property was $8,200, and that of the fixtures and accessory apparatus $3,050, while the working capital amounted to $2,000.

The products aggregated 1,742,500 pounds sold fresh, having a value to the fishermen of $34,260; 145,000 pounds frozen, valued at $4,200; 201,000 pounds salted, valued at $4,440, and 18,000 pounds smoked, worth $850. Two hundred and forty-six thousand pounds of fresh, and 5,000 pounds of frozen fish were whitefish, with an average weight of two and a half pounds each; 265,000 pounds of fresh, 40,000

pounds of frozen, and 135,000 pounds of salted, and 8,000 pounds of smoked fish were herring, averaging three-quarters of a pound; and 704,500 pounds of fresh, 100,000 pounds of frozen, and 66,000 pounds of salted fish were blue pike, averaging one pound each. The catfish amounted to 275,500 pounds dressed, all sold fresh, and the sturgeon to 114,400 pounds fresh and 10,000 pounds smoked. The other species taken were perch, saugers, wall-eyed pike, black bass, grass pike, and miscellaneous minor varieties. The secondary products were 9,625 pounds of caviare, $1,156; 300 pounds isinglass, $450; 550 gallons oil, $190; and 10 tons of fish for fertilizer, mostly eel-pouts, $50.

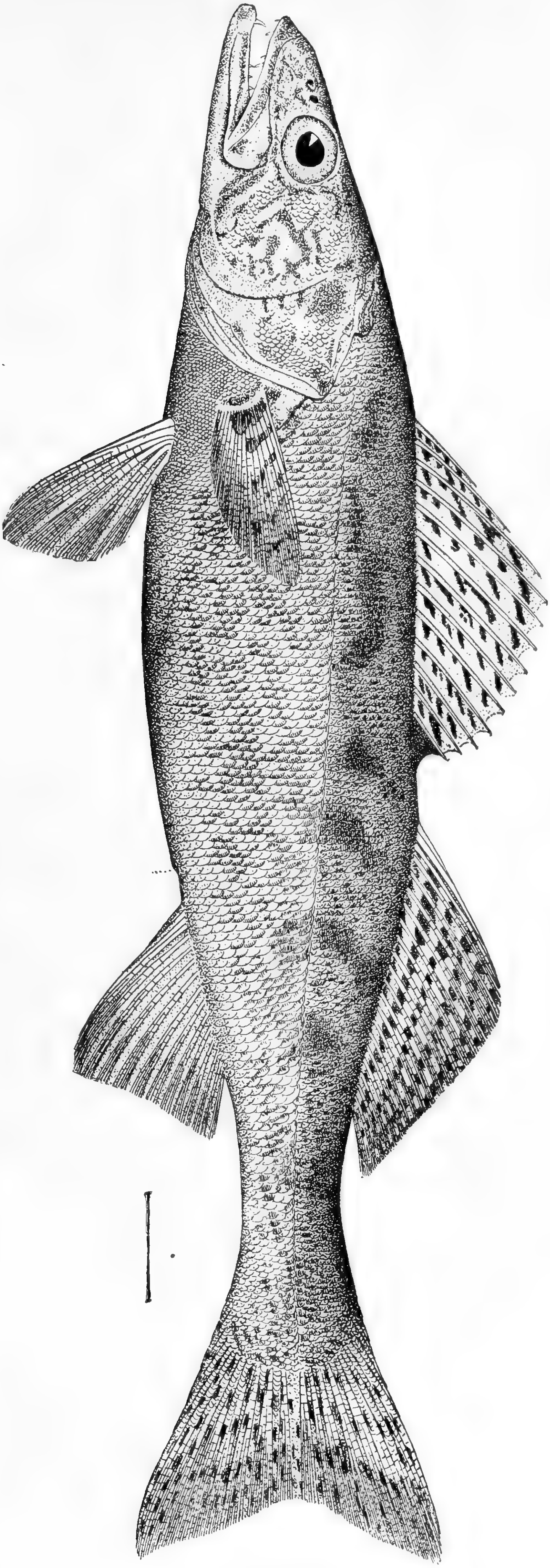
94. ERIE COUNTY, PENNSYLVANIA.

Character of the coast.—The State of Pennsylvania has about 50 miles of shore-line all included within the limits of Erie County. The lake coast is remarkable for its even contour, which is broken only in the vicinity of Erie. At that point there is a peninsula which, beginning at the general line of the coast, runs at first towards the northeast, and then trends around to the eastward so as to almost inclose a body of water 4 or 5 miles long, and from 1 to 2 miles wide. As this has a depth sufficient to admit the largest vessels, it forms an excellent harbor, one of the best upon the lakes, variously known as Erie Bay, Presque Isle Bay, and Erie Harbor. On the main-land adjacent to this harbor has grown up the city of Erie, with a population of about 30,000, four railroads, and considerable lake commerce.

Fisheries of Girard.—There are no net fisheries between Conneaut and Erie, except from the village of Girard, 12 miles east of the former and 16 miles west of the latter place. It is located 2 miles above the mouth of Elk Creek, which furnishes a harbor for small fishing boats. Its inhabitants number between 500 and 600, only a small proportion of whom are in any way dependent upon the fisheries, which are confined to a little catfish hooking, and four gill-net boats fishing from the mouth of the creek part of the time and during the rest of the season from Erie. The fish landed at Elk Creek are shipped fresh by rail to the Erie dealers.

Fisheries of Erie.—Among the industries of the place, the fisheries rank second in importance to the manufacturing interests. Both gill-nets and pound-nets are extensively used, though much the larger part of the products is derived from the former.

Species.—The principal species taken are herring and blue pike in April and early May, sturgeon in June, and whitefish in July, August, and November. More whitefish are landed by the fishermen at this port than at any other on the lake, if not on the whole chain of lakes. Sturgeon are numerous in this section but the catch is not very large, as no regular sturgeon nets are used and the ordinary gill-nets as a rule will not hold them. A few large lake trout are taken off Erie, ranging in weight from 25 to 40 pounds.



WALL-EYED PIKE OR DORY (*Stizostedium vitreum*).

Gill-net fishery.—The gill-net fishing at Erie began as long ago as 1852, and has been steadily prosecuted from that date to the present time. For a long time the only boats used for visiting the nets, often set as far as 20 miles out in the open lake, were little sail-boats which could not be employed except when the weather was favorable, and many inconveniences and interruptions were the consequence. In the years 1881 and 1882 one or two steamers from the western end of the lake were tried here with such success that one firm after another provided itself with vessels of this kind until in 1885 there were seventeen, valued at nearly $40,000, besides several others used for collecting fish. These steamers are small, measuring only from 3 to 13 tons gross, and are provided with iron-lined holds forwardand aft to receive the fish. Their fishing grounds covered a wide area, extending 30 or 40 miles in each direction from their home port and across the lake to within 8 miles of the Canadian shore. In addition to the steamers there were between forty and fifty sailing crews engaged in this fishery. The boats used are from 25 to 35 feet in length, rigged with foresail and mainsail, and carry from 2 to 5 tons of fish. They are made by local boat-builders. The twine of which the nets are made comes from Eastern manufacturers.

The fishing season is almost continuous, the only intermission being in winter, when there is too much ice in the bay and lake.

There was some gill-net fishing under the ice in 1884–'85 for blue pike and herring, the products being hauled to shore upon sleighs.

The nets used are 5 feet deep and from 38 to 74 fathoms long. Two kinds are in use, one with a large mesh of $4\frac{1}{4}$ to $4\frac{1}{2}$ inches for whitefish and wall-eyed pike (here called "pickerel"), and the other with a small mesh of $3\frac{1}{8}$ to $3\frac{1}{4}$ inches for blue pike and herring. Since whitefish frequent the same or closely adjoining grounds with the pike and herring, a great many small whitefish, weighing from three-quarters of a pound to 3 pounds, are caught in the herring nets. The whitefish caught in the large-meshed nets have a weight of from 3 to 7 pounds. Some herring averaging a pound each are caught in the large-meshed nets; those in the small ones weigh half or three-quarters of a pound and are thus surpassed by the slender blue pike which average a pound. Some of the nets are rigged with cork and lead, and others with the old-fashioned floats and stones.

Waste of fish in gill-net fishing.—Enormous quantities of whitefish are lost every season by spoiling in the gill-nets. Mr. Bower, on the authority of a prominent dealer at Erie, estimates that the waste is nearly or quite equal to the entire whitefish catch at the western end of the lake, west of Sandusky, amounting to at least 400 or 500 tons.

Gilled whitefish soon drown if there is much current, as there generally is at this end of the lake, and then bloating and decomposition ensue in a few hours. The arrangement of the nets is such that each gang is lifted not oftener than once in two or three days, and in summer

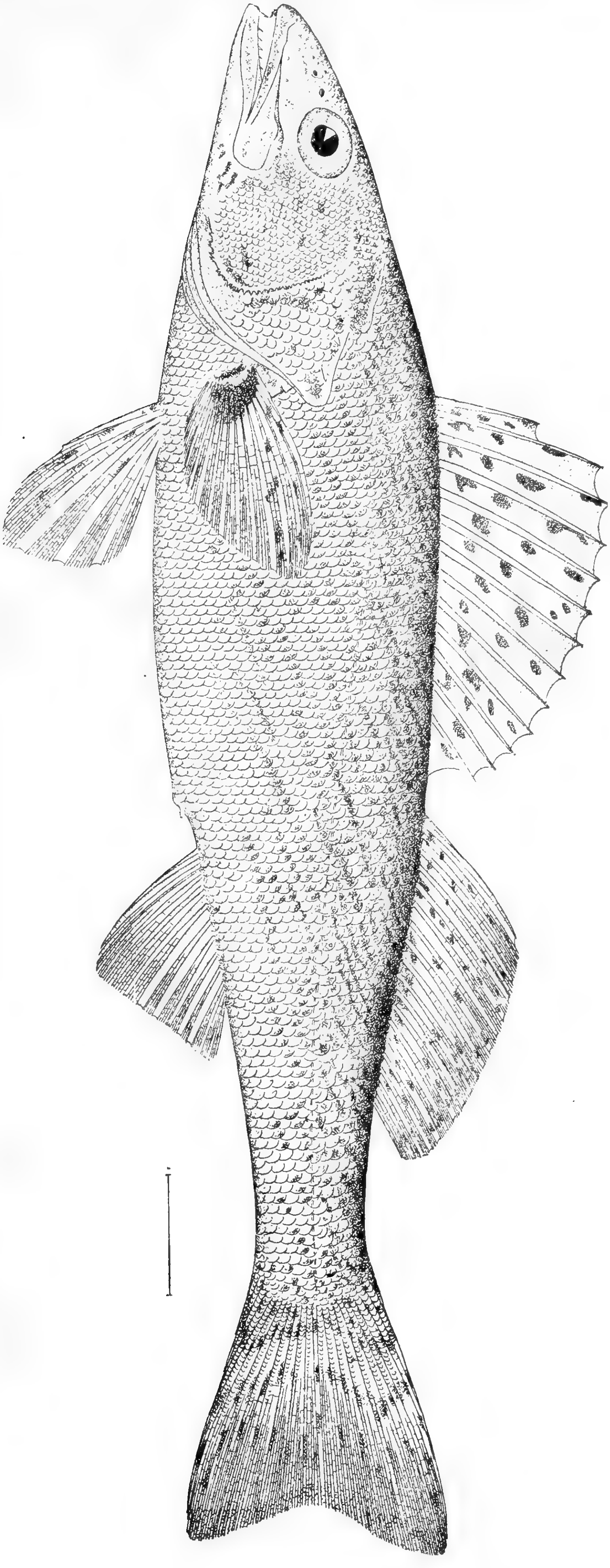
there is invariably a considerable number of spoiled fish at each lift; not infrequently when a storm or blow occurs and the lifting is delayed a day or two, more than half of the fish are found to be rotten and are stripped out and thrown back into the lake.

As late as October 10, and during fair weather, Mr. Bower saw more than fifty whitefish thrown into the offal barrels by the dressers at the fish-house out of a single boat-load, and he states "there is no telling how many the fishermen had thrown out when lifting."

Besides the fish which are thrown away, large numbers that are "doubtful" are brought ashore and placed upon the market, usually in a salted state. Very many of the whitefish are punctured in the side to allow the gas to escape.

Success of artificial propagation in maintaining fish-supply.—The pollution of the water by decaying fish has nearly spoiled some of the best gill-net fishing grounds, so that boats are now obliged to run out much farther than formerly. Notwithstanding these facts, whitefish seem to be increasing in numbers in the waters tributary to Erie, and the fishermen are unanimous in their opinion that the increase is due to artificial propagation, in which they manifest great interest. A new hatchery for whitefish propagation had just been built in 1885, but doubt was expressed as to whether it could be filled with eggs from this section except by penning the fish, a plan said to be entirely feasible, owing to the adaptation of Erie Bay to this purpose and the proximity of the pound-nets from which the living fish can be obtained. There is a small spawning reef for whitefish off Elk Creek, where a few ripe fish are caught in November, but not enough to supply sufficient eggs for the purpose in question, as the November run in this vicinity is not large.

Pound-net fishery.—The first pound-net was set in 1874. The gill-net fishermen were very much opposed to this form of apparatus, and through their influence a law was enacted in the Pennsylvania legislature prohibiting all kinds of net fishing in waters within the jurisdiction of the state, with certain exceptions, Lake Erie not being excepted. The limit of the state's jurisdiction over the waters of Lake Erie not being defined the gill-net faction held, by the advice of counsel, that it extended only a marine league from the shore. Such an interpretation of the statute effectually excluded the use of pound-nets, on account of the depth of the water beyond this limit, but had no effect upon the gill-netting, the grounds for which are outside the 3-mile line. Pound-netting was therefore discontinued from 1876 to 1884. In the latter year a prominent fishing firm who were in favor of pound-nets decided to test the matter of jurisdiction. They accordingly set a number of pound-nets, and were promptly brought before the local court and convicted. The case was then carried to the supreme court of the state, which decided that the law was constitutional, but held that the state's jurisdiction over the fishing interests of Lake Erie extended to the center of the lake. According to this interpretation the gill-net fishing



SAUGER OR SAND PIKE (*Stizostedium canadense*).

was equally illegal with the pound-netting, and both factions being now on the same footing joined forces, and in the spring of 1885 secured an amendment which removed all restrictions from the fisheries on the lake shore of the state except in Erie Bay, where net fishing of all kinds is still prohibited.

The pound-net grounds are limited to about 15 miles of coast, most of which is included in the peninsula by which Erie Bay is formed. Westward to Fairport, and eastward for 15 miles or more, the bottom is of smooth rock, and hence not well adapted to pound-netting.

All the pound-nets now in operation are set near the outer end of Presque Isle along 5 miles of coast-line. They are from 19 to 40 feet deep and have a mesh of 6 inches in the leader, 4 inches in the funnel and hearts, and 2 inches in the crib.

Catfish hooking.—From Erie to Elk Creek, inclusive, about twenty-five persons fish for catfish with set-lines for two or three months every summer, selling their catch chiefly to the Erie dealers.

Trade.—There are six firms which control the entire fish trade of Erie, owning all the pound-nets, seven or eight of the steamers, and more than half of the other gill-net boats. They handle nearly all of the fish caught at Erie, and several hundred thousand pounds of fresh and frozen fish, mostly trout and whitefish, from Lakes Superior and Huron. All of the firms salt considerable quantities of their whitefish, herring, and blue pike, and four of them have freezers. One of the warehouses has a freezing capacity of 150 tons, and two of the others 60 and 50 tons respectively.

Most of the sturgeon caught here, after being butchered, are sent to Toledo or Sandusky for salting or smoking. Three of the Erie firms have begun to manufacture caviare extensively and one of them smoked large quantities of sturgeon and herring for the first time in 1885.

From ten to fifteen men retail fish through the streets of Erie with hand-carts, and about a dozen country peddlers also are supplied by the Erie dealers.

About four-fifths of the fish shipped fresh from Erie are packed in 100 or 200 pound barrels, mostly the latter. The manufacture of these barrels forms about three-fourths of the business of three cooperage firms, with a capital of nearly $10,000, who employ about twelve men for the nine months in the year when the fisheries are actively prosecuted. The fish dealers use from 400 to 500 barrels a week during this period, for which they pay 30 cents each.

Two fertilizer factories with a capital of $12,000, employing eighteen men during the fishing season, are located just outside the city limits. They prepare about 250 tons of fertilizer annually, worth $30 a ton. Nearly all of this is manufactured from fish refuse, sheepshead, and unsalable fish.

Fisheries of Erie County east of the city.—The 18 miles of coast-line between Erie and the boundary of New York State are almost entirely

devoid of commercial fisheries. Numbers of anglers from Erie fish for black bass from Harbor Creek, 8 miles distant. Freeport, a few miles further east, situated on the lake shore, was once a famous fishing place, but no fishing of any consequence has been done there since 1881, though several hundred pleasure fishermen from North East and other places go there at odd times to angle for bass, perch, and pike.

Statistics of fisheries.—The fishing interests of Erie County gave employment in 1885 to 225 professional and 33 semi-professional fishermen, 49 preparators, and 3 mechanics, upon whom about 600 people were directly dependent. The floating property consisted of 19 steamers, 45 gill-net boats, 6 scows, 6 pound-net boats, 1 seine boat, and 35 small row boats, the whole having a value of $66,240. The number of gill-nets was 10,700, worth $34,542; two-thirds of which were for whitefish and trout, and the rest for blue pike and herring. There were 25 pound, nets, worth $10,800, and also a seine, several fykes, and a number of set-lines, having a combined value of a little over $1,000. Twenty-seven thousand one hundred dollars were invested in wharves and buildings, and nearly $12,500 in fixtures and accessories, including fish-cars, the additional cash capital being $27,000.

The products of the fisheries amounted to 10,313,500 pounds, whose value, at the rates paid by the dealers to the fishermen, would amount to nearly $240,000.

Statistics of fish handled by dealers.—The dealers handled about 10,600,000 pounds, of which about 82 per cent. were sold fresh, 8 per cent. were frozen, 6 per cent. were salted, and 4 per cent. were smoked. More than two-thirds of the fresh fish were herring and blue pike, the latter predominating; over 2,000,000 pounds were whitefish, and the rest were perch, wall-eyed pike, trout, catfish, bass, mullet, and half a dozen other kinds caught only in small numbers. Whitefish constituted nearly 30 per cent. of the frozen fish and 17 per cent. of the salt fish. Of the rest of the frozen fish nearly half were blue pike, and the rest were trout and herring, the latter in greater quantities. There were salted 140,000 pounds of herring, and 100,000 pounds of blue pike. Ninety-seven thousand five hundred pounds of caviare, with a value of nearly $10,000, were prepared.

95. CHAUTAUQUA COUNTY, NEW YORK, WEST OF DUNKIRK.

Nature of coast.—The section of coast between Dunkirk and the State of Pennsylvania is about 28 miles in length. It is rocky in the extreme and is broken in places by high ledges jutting out into the lake.

Fisheries of Barcelona.—The most important fishing community in this region is Barcelona, situated at the mouth of Chautauqua Creek. Its fishery interests were much more developed at one time than they were in 1885, and in past years it has been a very famous place for fishermen. Its inhabitants now are mostly farmers. A few people from in-

land towns visit the place at times and fish for bass. The fishing grounds are from 1 to 10 miles from the shore.

Fisheries of Ripley.—Ripley, a small village about 2 miles from the state line and 1½ miles inland, is the only other fishing center in this section that need be mentioned; its inhabitants are largely engaged in farming pursuits, and its few fishermen follow their occupation near the state line, off Twenty-mile Creek. There is a little pleasure hand-line fishing for bass and perch on the shore adjacent to this place.

Species and season.—Herring is the most abundant species found in these waters. It is taken in gill-nets at all times when there is no ice. Next in abundance are blue pike, which are caught on set-lines in the spring and fall. Whitefish are fairly common, but were not so numerous in 1885 as in the previous year. Trout are scarce, and are taken in gill-nets at all seasons. Bass and bull-heads are caught on set-lines and hand-lines in paying quantities. No sturgeon occur on this shore.

Disposition of the products.—A few of the fish are shipped to Buffalo and New York, but the great bulk are disposed of locally. None are salted for home use.

Statistics.—In 1885 the fishermen numbered 19, 9 being professionals and 10 semi-professionals. The apparatus they used consisted of 11 boats, 270 whitefish and trout gill-nets, 60,750 feet in length; 152 herring gill-nets, 33,300 feet in length; and 8,000 feet of lines, with 800 hooks. The boats were valued at $449, the gill-nets at $1,367.50, other apparatus at $158, and shore property at $365; the total value of the fishing investment being $2,339.50.

The following are the products from the year's fishing: 59,000 pounds of herring, 18,700 pounds of pike, 7,980 pounds of bass, 2,900 pounds of whitefish, 2,367 pounds of bull-heads, 1,000 pounds of mullets, 800 pounds of perch, and 700 pounds of trout. The total value of the fish was $2,397.

96. DUNKIRK, CHAUTAUQUA COUNTY, NEW YORK, AND VICINITY.

Description of the town.—Dunkirk is on a bay of the same name, about midway between Erie and Buffalo. The neighboring shore on either side is rough and rocky. The town has a population of about 7,500. It is a port of entry, with large piers and warehouses; and has extensive locomotive works and factories, giving employment to a considerable number of people.

Apparatus and species.—In 1879 it was stated of Dunkirk that only gill-nets were used in taking fish, the amount of which product was 40,000 pounds. Since then, however, there has been some changes which have tended to advance the fishery interests of the place.

The fishing grounds are in Dunkirk Bay and in the lake to the distance of 10 or 12 miles. It is thought by the fishermen that no spawning grounds of the whitefish exist in this vicinity, as it is observed that

in September and October the fish leave for the western end of the lake, to spawn, as the fishermen suppose.

In addition to whitefish, which are caught in July and August in gill-nets, herring, blue pike, bass, bull-heads, sturgeon, and trout are also taken. Herring are found in small numbers and are secured in gill-nets. Ice-fishing for blue pike was inaugurated in the winter of 1884–'85 and has become quite an important branch of the fisheries. The methods followed are similar to those of the Buffalo fishermen, from whom the idea was obtained. An improvement on the Buffalo mode, perhaps, is the use of shanties on the ice, some provided with stoves, built over the holes through which the fishing is done. About fifteen such buildings were employed in Dunkirk Bay in the winter of 1884–'85, when this fishery was prosecuted for eighty or ninety days. Ice-fishing is followed from 1 to 5 miles from the shore and is engaged in by about two hundred people. Bass are common, but were not so plentiful in 1885 as in former seasons. Bull-heads are taken in the spring and fall on set-lines. Sturgeon are very rare, and in 1885 were caught by only one man, who used set-lines. Trout are also uncommon.

Three steamers from Erie, Pa., fished off Dunkirk with gill-nets in June and July, much to the annoyance and discomfiture, apparently, of the Dunkirk fishermen, who are jealous of their fishing grounds.

Disposition of products.—The fish landed at Dunkirk are in most part shipped to Buffalo. There is some local demand, and peddlers with team and wagon carry fresh fish through the inland districts and find ready sale among the farmers and others.

Statistics.—Seven professional and 52 semi-professional fishermen were in this locality in 1885, in addition to the 200 persons engaged in ice-fishing. The apparatus used consisted of 9 boats, 230 whitefish gill-nets, 52,750 feet long, 100 herring gill-nets, 25,875 feet long, and 8,000 feet of set-lines, with 800 hooks. The amount of investment was $520 in boats, $1,360 in gill-nets, $262 in other apparatus, and $500 in wharves, buildings, and other shore property; total, $2,642.

The products were as follows: 73,100 pounds of blue pike, 10,500 pounds of bass, 9,730 pounds of whitefish, 4,200 pounds of bull-heads, 2,000 pounds of perch, 1,200 pounds of herring, 1,000 pounds of trout, 500 pounds of sturgeon, and 300 pounds of suckers, the whole being valued at $4,636.

97. IRVING, CHAUTAUQUA COUNTY, NEW YORK, AND VICINITY.

Description of the town.—The town of Irving, on Cattaraugus Creek, is the center of growing fishery interests. Many years ago there was a good harbor here, the place being a port of entry; but at present the mouth of the creek is obstructed by an extensive sand-bar. About 16 acres of land at the mouth of the creek are owned by the United States. Irving has a population of about 500, consisting mostly of

RED-HORSE SUCKER (*Moxostoma macrolepidotum*).

Americans, with a few Canadians and Indians. Farming is the occupation in which the greatest number of people are engaged.

Extent and character of the fisheries.—For two years prior to 1885 the fisheries had been on the increase, owing to the action of the authorities in licensing the use of pound-nets. As the law now stands a tax of $15 is levied on each pound-net set.

The fishing grounds are off Cattaraugus Creek, on the government land at the mouth of that stream, where men have fishing shanties, and in the creek itself, where seining is followed in the spring. Six fishermen from Erie set gill-nets off the creek in the spring of 1885.

The nets used at Irving are bought in New York City, not many, if any, of the fishermen making their own apparatus, as is done at many other localities on the lakes. The mesh of the pound-nets is regulated by the state, 3 inches being the minimum size for the bowl and 6 inches for the wings and leader. The pounds at Irving have leaders 1,930 feet in length and are staked on clay bottom, with ash poles, in 32 feet of water. The pounds at Irving in 1885 were fished from March 11 to July 15, and from August 20 to November 1. It is thought that if the present law continues in force, a large number of new pounds will soon be placed in the lake at this place. The supply of fish certainly warrants the use of more productive and more extensive fishery apparatus than has heretofore been employed.

Gill-nets are set for whitefish, herring, and pike. Set-lines are quite extensively used for sturgeon, bull-heads, etc. Seines are hauled in the spring and fall for suckers, bull-heads, pike, etc.

Fisheries of Silver Creek.—At Silver Creek, a small village about 2 miles from Irving, twenty people fished with hand-lines in 1885 and sold the fish thus caught to supply local demand. No gill-nets were set there, but a few seines were hauled by the farmers, chiefly for their own use.

Species.—Commercially, sturgeon occupy the first rank among the species found in this locality. They are taken in pound-nets and on set-lines baited with minnows. Spawning grounds of the sturgeon probably exist near the mouth of the creek. Bull-heads are abundant, and are caught in seines and on set-lines. Pike, herring, bass, and mullets are also plentiful. Whitefish are not particularly common, and trout are unknown.

Trade and preparation of products.—Many of the fish are sold to peddlers, but the larger part are shipped to Cleveland, Buffalo, and New York. Twenty or thirty farmers get their supply of fish for salting from the pound-nets. Sturgeon are prepared for shipment simply by removing the head and tail, and are not skinned and cut in pieces as is done in Lake Ontario and elsewhere. When dressed in this way a sturgeon weighs about 30 pounds.

The roe, swimming bladder, and skin of the sturgeon are here utilized on a small scale in the preparation of caviare, isinglass, and oil,

respectively. Only one man is engaged in this line of work. The caviare is prepared by a secret process and sent to Russia and Germany, through a New York firm. Sounds to be used for isinglass are cut open and soaked in water for twenty-four hours; they are then skinned and only the inside membrane is preserved.

Statistics.—Nine professional and 29 semi-professional fishermen, and 1 preparator were engaged in the fisheries of this section in 1885. They used 29 boats; 30 whitefish gill-nets, 6,750 feet in length; 65 herring gill-nets, 14,550 feet in length; 2 pound-nets; 7 seines, 3,102 feet in length; and 121,000 feet of set-lines, with 10,600 hooks.

The capital invested amounted to $801 in boats, $450 in gill-nets, $2,400 in pound-nets, $200 in seines, $80 in set-lines, $1,868 in other apparatus, $665 in wharves and buildings, and $300 in cash capital, the total investment being $6,764.

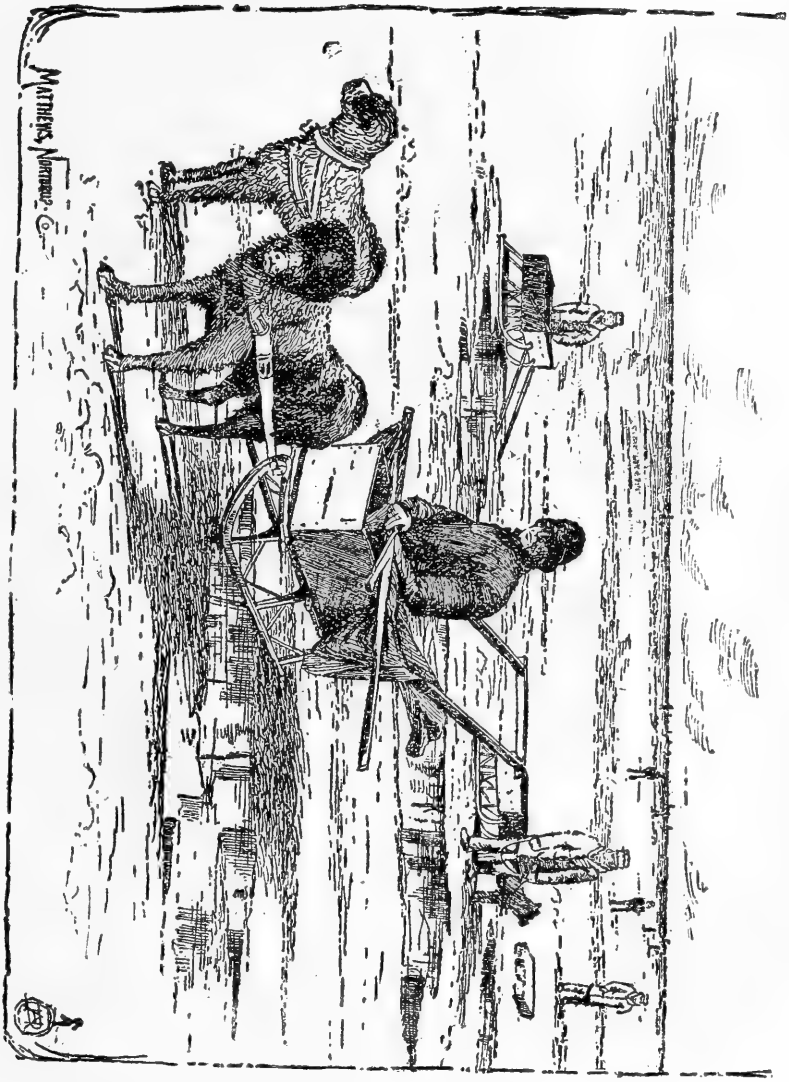
The products were as follows: 62,500 pounds of sturgeon, 29,550 pounds of bull-heads, 22,200 pounds of bass, 23,700 pounds of pike and pickerel, 14,500 pounds of mullets, 11,000 pounds of herring, and 4,150 pounds of whitefish, the total value being $7,055. The manufactured products were 5,500 pounds of caviare, 200 pounds of isinglass, and 250 gallons of sturgeon oil, valued at $1,050.

98. BUFFALO AND ERIE COUNTY, NEW YORK.

Commercial importance of the city.—Buffalo is at the head of the Niagara River. Its harbor facilities are excellent, and many lines of steamboats plying between the various American and Canadian ports on the lake make it their headquarters. The railroad traffic is very extensive, ten or more roads entering the city from as many directions. The Erie Canal is also an important factor in the commercial development of the place. The fish consumption of a city with over 200,000 people is necessarily great; and in order to meet the demand an important business, giving more or less permanent employment to many persons, has sprung up, and an extensive trade with Canadian fishermen has been developed.

Coast-line of the county.—The coast-line of Erie County extends first in a southerly and then in a southwesterly direction from Buffalo to Cattaraugus Creek, a distance of about 30 miles. The shores of the lake are mostly sandy or gravelly, here and there broken by rocky ledges.

Fishery centers.—Outside of Buffalo and vicinity the fishing centers of Erie County are of little importance. The only communities where any fishing is carried on are Bay View, about 7 miles from Buffalo, a small place with no fishery interests save a little pleasure fishing for bass, pike, perch, etc.; Lake View, 9 miles farther to the southwest, with 275 people, mostly farmers, where there is a little trolling from June to November, a little seining in May and June, and a little fishing with gill-nets by the farmers for their own use, bass, pike, and perch



A BUFFALO FISHERMAN AND HIS DOG TEAM.

(By permission of the *Buffalo Express*.)

being the chief kinds of fish caught; and Evans and Angola, inland villages, a few fishermen from which haul seines on the adjacent beaches and operate a few set-lines in the lake, catching small quantities of sturgeon and whitefish in addition to the other species mentioned above.

Enumeration of Buffalo fisheries.—The principal fisheries in the vicinity of Buffalo are the ice fishery, the set-line boat fishery, the grapnel sturgeon fishery, and the gill-net fishery. These will be considered somewhat in detail.

Ice fishing.—This is one of the favorite and important methods followed in the vicinity of Buffalo, and is pursued principally by dockmen, sailors, and laborers who, because of the suspension of lake traffic after freezing weather sets in, are otherwise idle in winter. The fishing begins as soon as the ice is sufficiently solid to bear the weight of men and teams, usually about the 1st of December, and continues until the spring break-up, about the last of March. Usually the ice-fishing season lasts about ninety days. Blue pike is the species taken in greatest quantities, other species, as yellow pike, perch, trout, herring, and sturgeon, being caught in only limited numbers. The men start for the fishing grounds—1 to 10 miles from the shore—about daylight; many of the fishermen have sleds drawn by dogs to convey them to the grounds and to bring back the fish at night. It is estimated that one hundred and seventy-five sleds and two hundred and seventy-five dogs are thus employed. The dogs are mostly of the Newfoundland breed, but all kinds and varieties that will pull in harness are pressed into service; one or two dogs are fastened to each sled, and a good team will travel 6 miles an hour, if the wind be propitious. The sleds are cheap affairs, a few being expensive and stylish; the average value is not more than $3.50. A number of men frequently combine forces and bring in large loads of fish. A man with but one dog may often be seen pulling in harness with the canine.

Regarding the number of people engaged in this fishery and its extent, Messrs. Jones and Trevallee, as the result of personal observations and numerous inquiries, state that five hundred men would be the very lowest estimate, and that eight hundred or a thousand would perhaps be nearer the real number. A fair allowance would be a quart of minnows a day for bait for each man, with which 20 pounds of fish are taken; and ninety days being the length of the fishing season, the lowest estimate will give nearly 1,000,000 pounds of fish as the yearly product of this fishery, valued at not less than $50,000. Another estimate is given in the following paragraph which differs somewhat from the above figures; but either will show how important and extensive the business is. Under date of April 19, 1887, Mr. O. A. Trevallee, of Buffalo, writes:

There have been caught on the ice this season, between January 20 and April 5, 585,795 pounds of blue pike, 7,398 pounds of perch, and 5,090 pounds of herring. You could add at least 20,000 pounds to these figures.

This would seem to indicate a falling off in the catch since 1885.

The following interesting notes on the ice fishery are extracted from a letter of Mr. Thomas Williams, keeper of the Buffalo Life Saving Station:

The fisherman's outfit for this kind of fishing, here called "tip-uping," in addition to the sled and dogs, consists of an ax, shovel, ice-chisel, and the "tip-up," or catching apparatus. The ice-chisel is made by fastening a sharp piece of steel, about 2 inches in width, into the end of a pole 5 feet in length; this implement is often required to free the hole cut in the ice of the "slush" or ground ice that may have formed under the clear ice, and this is often very troublesome, especially when high winds prevail at the time when the ice forms upon the lake.

The "tip-up" is novel in its arrangement, and is constructed of two sticks, 18 and 24 inches long, respectively, 1 inch wide, and a half-inch thick, firmly tied together with twine in the form of a cross, the free end of the line being attached to a hollow lead sinker by means of a loop of copper wire driven through the sinker, the ends of the wire being brought out below and bent at right angles for the attachment of the lines with the hooks appended. Each "tip-up" has two hooks, which are suspended about 18 inches below the sinker. The hooks are baited with minnows and are lowered through the hole in the ice to within 3 or 4 inches from the bottom. The ends of the short cross-stick rest on the ice on either side of the hole, the short end of the long stick being over the center of the hole. The line is caught in a number of turns around this stick so that the weight of the sinker may be just sufficient to make the frame lie flat upon the ice. When the fish is nibbling at the bait it causes the end of the cross to *tip up*, whence the name; and when the fish suddenly seizes the bait the long arm becomes almost perpendicular to the surface of the ice and shows that the fish has been caught. The fish is then drawn to the surface, taken from the hook, the latter freshly baited and lowered to its former position. The hole, to be properly cut, should not be over 18 inches in width, but may vary considerably in length. The fishermen, for mutual protection, strictly enforce this rule concerning the width of the holes, since otherwise the deserted holes, when once blown full of the ever-drifting snow, must too often be the means of a bath or even death in the ice-cold waters of the lake.

The minnows used for baiting the hook abound in the outer harbor and at the mouths of the numerous little streams that flow into the Niagara River; they are caught in dip-nets and sold by the quart to the fishermen at prices varying with the supply and the demand, by parties who make this their business during the winter and spring.

The kinds of fish taken at this season of the year are blue pike, chiefly, and perch, yellow pike, cisco, lake trout, herring, and sturgeon, caught in smaller quantities. The daily catch of each man will, at the lowest estimate, average 10 pounds; and if we consider that two thousand fishermen are thus engaged—sometimes there are many more—we shall have as the total catch of a short season 1,800,000 pounds. This estimate I am sure can be relied upon as correct and I am positive it will fall short of the actual amount taken some seasons. I have often taken as much as 180 pounds of blue pike in one day, but, of course, there will be days when none are caught.

Each fisherman has from three to five holes in the ice under his charge. The minnows used for bait consist of "chubs," "silversides," etc., and on their abundance and cheapness depends the extent of the fishery. The price of a quart of minnows varies from 10 cents to $1, 25 cents being the average. Only a few of the fishermen catch their own bait.

The following additional accounts of the ice-fishery are descriptive of the season of 1887. The issue of the "Buffalo Express" for April 3, 1887, says:

The past winter has been one of unusual profit and hazard to the lake fishermen; of profit, because the season has been long (still continuing, in fact), the catch plenti-

ON THE FISHING GROUNDS.

(By permission of the *Buffalo Express.*)

BRINGING HOME THE FISH.

(By permission of the *Buffalo Express.*)

ful, and the market active; of hazard, because the ice has more than once broken up suddenly while the men were out upon it, giving them narrow escapes from death, and causing their friends and families great anxiety as to their safety. On January 20 the ice broke up under a sudden thaw and a brisk southwest wind, which played havoc with it. Five hundred fishermen were out that day, it is said, and so suddenly did the ice break up that many did not realize their danger until they found themselves cut off from shore by ribbons of blue water. Several drifted down with their dogs and sleds on the floes until the latter jammed together with the shore ice, when they were enabled to cross safely to land. A few were carried down the river and only rescued by boats. No human lives were lost, though a few dogs were drowned. A more serious storm occurred on February 26, when two fishermen, Thomas Cody and John Leary, were frozen to death on the ice. A party of eleven narrowly escaped at the same time.

The life of the ice fisherman, it may be seen by this, is not an ideal one, unless danger is considered an essential ingredient. But even he who loves danger must demur at the early hour of rising necessary that the fisherman may start at 5 o'clock in the morning for the fishing grounds. The exposed position which he must take on the open ice is not conducive to comfort either, except in still weather, and still days on a large body of water in winter are not so plentiful as they might be.

The fisherman's outfit consists of a light sled with a box on it large enough to hold his catch of fish, and in that are his dinner, his bait of minnows caught in the Niagara at Black Rock, and an ax for cutting through the ice, and several sets of fishing tackle. Some fishermen depend on two or three lines while others set a dozen. They must all be long enough to land the bait on the bottom of the lake. The cutting wind makes necessary a sort of screen, consisting of light canvas fastened on two short sticks, for comfort or at times to prevent one from freezing. With this barrier between him and the blast the angler is happy—if the fish bite readily.

The dogs that draw the sled are an important part of the outfit. All sorts of canine specimens strong enough to drag a sled are pressed into the service, though some fine ones are found among them. The animals are mostly large and, as a rule, very intelligent, and though they are tired they show that their instincts are not forgotten even in harness, and when once turned loose they are at once all dog again. They are generally true to their masters, though occasionally a dog comes in driven alone with an empty harness hanging on the other side of the pole, an intimation that truancy is not unknown. The harnesses are usually very neatly made, and show the workmanship of a tradesman.

The amount of fish brought into port averages during the season from 3 to 10 tons a day. From 60 to 200 pounds is counted a good day's catch for one man. Blue pike or perch are the fish chiefly caught. They sell at an average of 4 or 5 cents a pound, so that a day's fishing means the distribution of a round sum of money. On one of the fine days last February it is estimated that over 600 fishermen were out on the ice. From these figures something of an idea may be obtained of the importance of this winter industry, by which Lake Erie gives subsistence to many families.

Mr. Thomas Williams, under date of March 16, 1887, writes:

This season's ice-fishing began in earnest about January 1, 1887, and has continued with almost unabated vigor up to March 15, when the ice began breaking up. There were a greater number of persons engaged in this fishery this season than ever before, and the catch has been very good. The fish taken are mostly blue pike; there are, however, a few sturgeon and an occasional lake trout caught. I took particular pains one day during the latter part of January to make a close estimate of the amount of fish taken that day; the weather was fine and the fishing was good. I was surprised at the result of the day's work; over 25 tons of fish, mostly pike, had been caught. This, of course, could not be said of each day's fishing, but it will be a low estimate to put the amount taken daily at 9 tons, during a period of about two and a half months. The selling price of the fish has ranged from 3 to 7 cents per pound, and

the total amount realized from the season's fishing is between $65,000 and $70,000. As this has been the most productive of seasons, so it has been the most severe. The waters of the lake froze over very quickly last winter, and there being no heavy blows usually so prevalent here during December, there was no slush, and no anchor-ice formed which serves to hold the main body in place. On several occasions gales set in suddenly, causing the ice to move and pile up, endangering the lives of hundreds of fishermen who were out upon the lake at the time. * * *

Set-line fishery.—April and May are the months in which this fishery is mostly pursued; it is also followed to a less extent during June, and from September till the closing of the lake by ice. The boats or skiffs employed are clinker-built keel craft with sharp bow and stern; they measure about 18 feet in length, 4 feet in width, and 15 inches in depth, and carry two pairs of oars. About fifty boats, carrying two men each, were employed in this fishery in 1885. Set-lines, baited with minnows, are used, and the species caught are chiefly pike, with a few perch and sturgeon during the month of April, and pike, sturgeon, a few whitefish, perch, herring, mullet, and pickerel during the months of May and June; while in the fall pike are again caught in greatest quantities, and next in numbers come perch and sturgeon. About the middle of June the pike begin to migrate from the American side of the lake to the northern shores, and these are followed by the sturgeon about the middle of July, neither species returning till the autumn gales set in from the south and west. The use of sail-boats carrying nets instead of set-lines is becoming more and more extensive. In the spring of 1887 over twenty were thus employed while in 1885 there was only one, as Mr. Williams states. The leaders or ground-lines of the set-lines are first placed in the water and heavily anchored, and then the hooks that have been previously baited are tied on at distances of 2 or 3 feet, the line being raised for that purpose by means of a small grapnel. The lines are left to fish during the night and freshly baited hooks are provided each day. It has been found that sturgeon and pike are caught in the greatest quantities when the lines are set over red clay and mud bottoms.

Grapnel sturgeon fishery.—This is carried on from the middle of May to the 1st of July, during which time the sturgeon are spawning. The fishery is engaged in by boat fishermen and the method is essentially by trolling. The hook or "grapnel" is somewhat similar in shape to a small boat anchor, and is provided with three or four prongs which come to a sharp point and are slightly barbed. The shank of the hook is heavily leaded. A "gaff-hook," fastened to a pole about 3 feet in length, is the only other implement required. The manner of using the grapnel is thus described by Mr. Thomas Williams:

A row-boat, manned by two men, is pulled to the spawning-grounds of the sturgeon, and as soon as a school makes its appearance, one man rows leisurely, but steadily and quietly, in its direction, the other fisherman being seated in the stern of the boat with grapnel and line in hand, keeping watch on the fish and directing the movements of the boat. When the vicinity of the school is reached, the hook is lowered to the bottom and allowed to drag behind the boat. When the grapnel is felt

to strike a fish rolling upon the bottom in the manner hereafter mentioned, the line is quickly gathered in and the sturgeon drawn to the surface, where the first struggles begin. The flounderings of the fish are apt to disengage it from the hook and the gaff-hook has to be driven with alacrity and dexterity into the sturgeon's head. The fish is then drawn aboard, and the fishing continues until the boat is loaded or the school disappears. The quantity of fish taken in this way is usually quite enormous, and though necessarily difficult to compute with accuracy, can be safely estimated at 3,000,000 pounds during the fishing period of fifty days.

The sturgeon caught in the vicinity of Buffalo vary in length from 3 to 9 feet. They are sometimes taken weighing 180 pounds, and will probably average 120 pounds. Mr. Williams thinks that a sturgeon loses very nearly two-thirds of its weight in dressing, the female wasting a little more than the male, because of the roe. Roes weigh from 30 to 60 pounds each, the average weight being about 40 pounds.

Writing on the habits of sturgeon during the spawning season, the observer above referred to states that—

They (the sturgeon) always run in schools or droves, and deposit their spawn along the seams occurring in the rocky ledges, so peculiar to our shores at this end of the lake, especially at the head of the Niagara River. I have often watched the female sturgeon running her spawn, closely followed by the male, which seemed to milt over the spawn as fast as it was run by the female. Frequently in the male sturgeon have I found parts of the spawn which he had evidently eaten. A peculiar habit of the sturgeon is observed after spawning. They are noticed rolling over and over on the bottom, faster than one can count; then suddenly spouting to the surface, they leap completely out of the water, falling back with a loud splash, which betrays their presence to the fisherman who may be trolling for them.

About seventy-five men are engaged in the grapnel sturgeon fishery in the vicinity of Buffalo. The fishing grounds are from 8 to 12 miles from the shore.

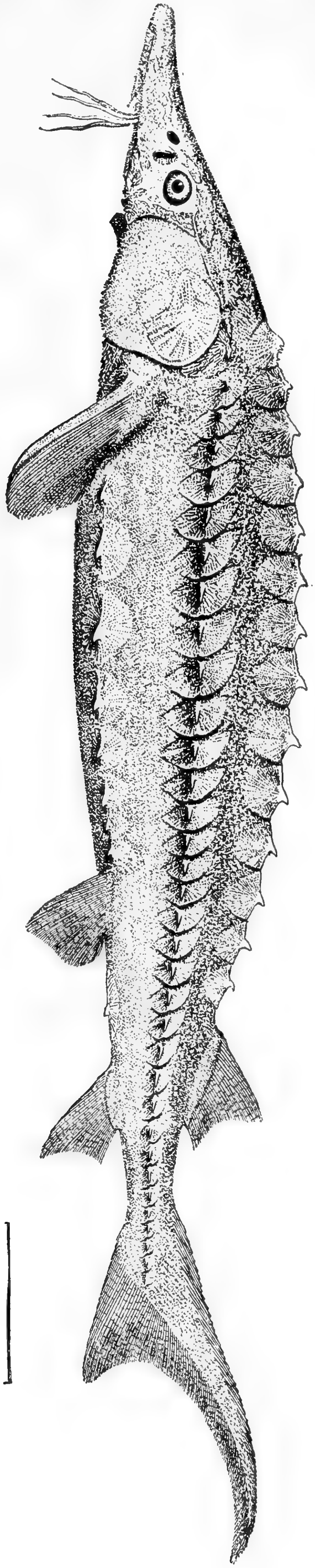
Many fishermen and observers are inclined to the opinion that this fishery should be discontinued, taking the ground that sooner or later it must result in the serious decimation of the sturgeon, if not in their complete or practical extermination. Aside from the fact that a very great many fish which the fishermen never secure are maimed and fatally wounded by the trolling hooks, a far more important cause for apprehension exists in the fact that this fishery is carried on only during the spawning season, when, of all times, the fish should be unmolested and protected. That there is cause for thoughtful consideration of this matter is shown by the annual diminution in the quantity of sturgeon taken.

Other fisheries.—Sturgeon are caught in the spring and fall in gill-nets, which are set to the number of thirty or more in suitable places. Gill-nets are also used for whitefish during the spring and autumn months. A few seines are hauled for catfish, herring, mullet, yellow pike, and bass. Angling for bass and pike is indulged in from June to October by many people from Buffalo and inland towns. The use of pound-nets in New York waters is prohibited, and fishing with nets and seines is not allowed in the rivers. There is a law in force forbidding the use of nets the meshes of which are less than $4\frac{1}{2}$ inches.

Disposition of catch, prices, etc.—Mr. Williams says that the fishermen, as a rule, dispose of their fish by selling directly to the dealers, at prices ranging from $1\frac{1}{2}$ cents per pound during the early summer and fall months to 7 cents per pound during the lenten season. The dealers, in turn, after supplying the local demand, freeze the whitefish, pike, and perch, and ship them in a frozen state by means of refrigerator cars to the Eastern markets, where they are readily sold at a good profit to the shippers. The fishermen sell their entire catch of sturgeon chiefly to one or two dealers, at prices varying with the supply and demand from 2 to 7 cents per pound dressed, and receive from 25 to 75 cents apiece for the roes. The methods of preserving the sturgeon and roe is not well understood by the fishermen, and they are therefore obliged to sell to the dealers, who smoke a considerable proportion of their supply of sturgeon and make caviare of the roes. The caviare made at Buffalo has the distinction of being of a very superior quality, and is shipped to nearly every part of the globe, while smoked sturgeon prepared in Buffalo is to be found in nearly all the large Eastern cities. The fish caught in the ice-fishery are used in the homes of the fishermen, considerable quantities are sold to peddlers, some are shipped to the inland markets, and the fish dealers in Buffalo get the remainder. From 5 to 7 cents per pound are received by the fishermen.

Dealers.—The fish trade of Buffalo in 1885 was chiefly in the hands of three firms. Two of these have freezing apparatus with a combined capacity of 460 tons; only one dealer prepares any caviare. Only a very small percentage of the fish handled at Buffalo comes from American waters. One house has but one-tenth of its fish from American fishermen, nine-tenths coming from Manitoba and from a branch house in Toronto; another firm gets about one-fourth of its supply from the American side of the lake, the larger portion of the remainder being received through an agency in Canada; while one-third of the remaining whitefish, sturgeon, and pickerel was taken in provincial waters. The number of persons employed in 1885 in the capacity of shoresmen and preparators was thirteen. The wharves, buildings, apparatus, etc., used in connection with the business were valued at \$41,400. From statements furnished by these firms the following table has been prepared, showing in the aggregate their operations during 1885:

Species.	Total quantity of fresh fish purchased from fishermen.	Fresh fish bought from Canadian fishermen.	Average price per pound paid to fishermen.	Fresh fish frozen before shipping.	Fresh fish smoked.
	Pounds.	*Pounds.*	*Cents.*	*Pounds.*	*Pounds.*
Whitefish	1,294,000	880,300	$5\frac{1}{2}$	240,000	
Trout	1,144,000	687,000	$5\frac{1}{2}$	122,000	
Sturgeon	170,000	60,000	$5\frac{1}{2}$		80,000
Pike (blue)	200,000	54,000	$4\frac{1}{2}$	55,000	
Pike (yellow)	289,000	190,000	5	58,000	
Pickerel	284,000	268,000	5	60,000	
Bass	9,000	1,000	$7\frac{1}{4}$		
Total	3,390,000	2,140,000	$5\frac{9}{16}$	535,000	80,000



STURGEON (*Acipenser rubicundus*).

The manufactured products consisted of 10,000 pounds of caviare.

Statistical summary.—Without taking into consideration the men engaged in the ice fishery off Buffalo, there were, in Erie County, in 1885, 383 semi-professional fishermen, and 16 shoresmen and preparators. The most reliable estimates place the number of ice fishermen at 800 or 1,000 in 1885.

The apparatus consisted of 133 boats; 33 sturgeon gill-nets, 103,613 feet in length; 50 whitefish and trout gill-nets, 108,166 feet in length; 4 seines, 1,720 feet in length; 930,000 feet of set-lines, with 62,000 hooks; 425 fish-cars, and 175 sleds. The capital invested in boats was $2,640; in gill-nets, $506; in seines, $185; in set-lines, $625; in fish-cars, $6,300; in other apparatus, $1,980; in wharves, buildings, etc., $34,037; the working capital being $22,000. The total amount invested in the fisheries was $66,473.

The amount of fish taken was 2,011,425 pounds of pike and pickerel, 3,660,000 pounds of sturgeon, 14,000 pounds of bass, 8,000 pounds of perch, 13,175 pounds of whitefish, 12,000 pounds of herring, 5,200 pounds of trout, and 250,000 minnows used for bait, the total value of the catch being $305,241.87.

VIII.—THE FISHERIES OF LAKE ONTARIO.

99. GENERAL REVIEW.

Geographical description.—Lake Ontario, the smallest of the chain of Great Lakes, is 185 miles long, by an average of 40 wide. Its maximum depth is 123 fathoms about 12 miles north of Sodus Point. It separates the State of New York from the Province of Quebec, the American shores bordering it on the southeast from Niagara to the entrance of the St. Lawrence River, a distance of 145 miles in a straight line, or, by following the indentations of the coast, 265 miles. The Canadian territory occupies the whole northern, western, and part of the southern shores of the lake, a distance of 300 miles.

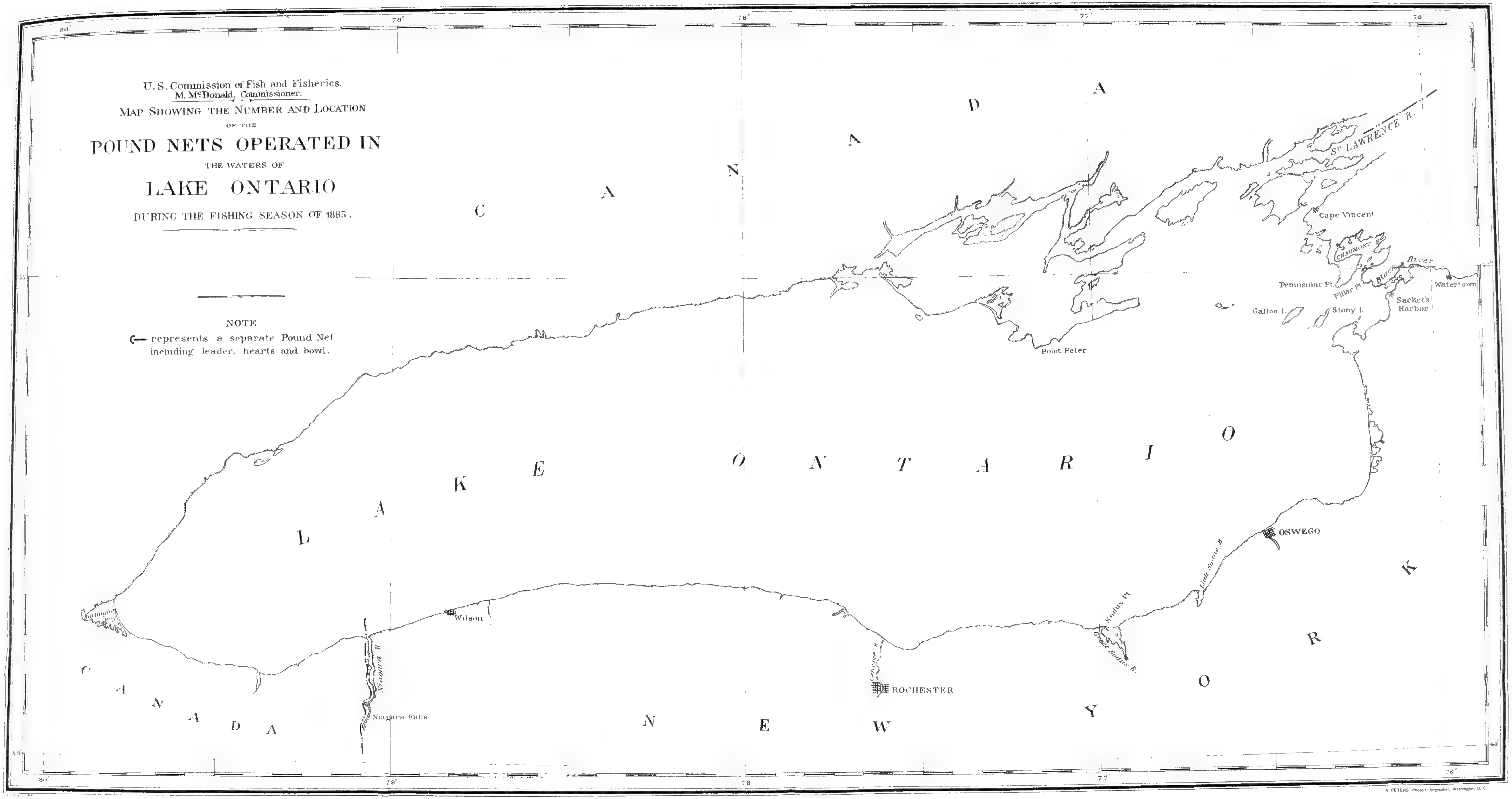
Beginning at Niagara River, the shores of the lake consist of a bank varying from 10 to 20 feet in height, increasing to from 30 to 40 feet eastward of Old Orchard. At Charlotte they are again low, but between that point and Oswego they are similar to those of the western end of the lake. East of Oswego, the region known as Mexico Bay is low and sandy, and the broken coast of Jefferson County beyond Stony Creek is also comparatively low. This last stretch is very irregular, consisting of peninsulas and islands which are separated by bays of considerable size. With this exception the southern contour of Lake Ontario is very even, interrupted only by the bays west of Charlotte, Irondequoit Bay west of Rochester, and Big Sodus Bay.

The only river of importance, excepting the Niagara, is the Genesee, the others being scarcely more than creeks, though some of them are navigable for a few miles by small craft.

The land in the vicinity of the lake is fertile, and for its entire length it is cut up into small farms and orchards. The population is composed largely of Americans, who raise chiefly wheat, barley, potatoes, and fruits.

The principal cities, mentioned in order of their importance, are Oswego, Sackett's Harbor, and Charlotte. Most of the villages, instead of being on the banks of the lake, are located several miles inland, either on or near the railroads which traverse the entire region. The leading fishery centers are at or in the vicinity of Cape Vincent, Chaumont Bay, Sackett's Harbor, Port Ontario, Oswego, Big Sodus and Irondequoit Bays, Olcott, and Wilson.

History and present condition of the fisheries.—Fishing has been carried on to a certain extent from the earliest settlement of the region,


U.S. Commission of Fish and Fisheries.
M. McDonald, Commissioner.
Map Showing the Number and Location
of the
POUND NETS OPERATED IN
THE WATERS OF
LAKE ONTARIO
DURING THE FISHING SEASON OF 1885.
NOTE
represents a separate Pound Net including leader, hearts and bowl.
CANADA
LAKE ONTARIO
NEW YORK
CANADA
St. LAWRENCE R.
Cape Vincent
CHAUMONT B.
Black River
Watertown
Peninsular Pt.
Pillar Pt.
Sacket's Harbor
Galloo I.
Stony I.
Point Peter
OSWEGO
Little Sodus B.
Sodus Pt.
Great Sodus B.
Genesee R.
ROCHESTER
Wilson
Niagara R.
Niagara Falls
Burlington Bay
80°
79°
78°
77°
76°
44°
43°
N. PETERS, Photo-Lithographer, Washington, D.C.

but has never been as important as in the other lakes. The earliest fishermen used seines where the shores were suitable, and these are still employed in considerable numbers in Mexico Bay, and at several other points. The principal fisheries, however, at the present time are carried on with gill-nets, trap nets, fyke-nets, and set-lines.

The following account of the history of the fisheries of Lake Ontario is taken from the Syracuse Herald for July 5, 1885:

The business of fishing as a means of livelihood along the shores of the great lake and the St. Lawrence River, especially in the American waters, is rapidly decaying and in a few years will have passed into the countless and unwritten traditions for which the rocky bluffs and swampy lowlands forming their shores have a peculiar charm. From the time when the Mohawks and the Hurons located their fishing-grounds on the great waters and there sought the finny tribes until the more civilized but less far-seeing white men first dropped their miles of meshes into the lake, these waters were supposed to contain an inexhaustible supply of fish. But time has proven otherwise. While the direct shore-lines of the lake and the river are sterile and rock-bound, yet a few miles back are found some of the best and richest farming lands in the State. This fact, together with the location of trading posts and barracks at convenient points at an early time in colonial history, naturally led to a settlement of the contiguous country, and in proportion to the increase of population in the interior, with its increasing demand, the fish business sprang into considerable dimensions, and hundreds of families were supported by it. In this connection arise tales of toil, privation, and hardship, of loss of life and property by wind and wave fully equal to those sung by the poet of the fishermen on the "Banks," or of those stories from the capes of New England, so gracefully perpetuated by a writer in a recent and well-known publication. This history of the northern border still remains untouched by the scholar's pen, and affords an ample field for efforts in this direction.

As the demand grew beyond the supply capital stepped in. Immense concerns, with fleets of boats, hundreds of miles of nets, and thousands of men were soon at work, and even railroads were taxed to carry the products of their labor. For five or six years fishermen coined money. Then came the inevitable reaction. Fish became scarcer, sportsmen began to appreciate the grounds nature had selected for them, the game fish suddenly came under the protection of stringent laws, waters always the best for fishermen were freed from nets, and net fishing there was forever proscribed. Steam came into use and Canada became a formidable rival, her grounds yielding more and finer fish. Weaker concerns closed their doors, stronger ones branched farther out, once lively towns became dead and musty, nets rotted on the drying-wheels, and idle sails flapped lazily on the masts in the harbors. Then sprang up the profession which stepped into the vacancy and brought with it new life and courage. This was the trade of the guide or oarsman. The tourist came; magnificent hotels were erected; the St. Lawrenc River skiffs became noted; the old fisherman-for-business was still a fisherman, but for pleasure only. The minnow and the trolling-spoon took the place of the pound-net and the gill-net, and although the reaction is not yet complete, it is yearly growing, and contentmemt and prosperity are gradually settling down once more on a class of people from whom law and nature have wrested one occupation merely to give them another in its stead.

Pound-nets and trap-nets.—Pound-nets were introduced into Lake Ontario at Black River Bay, near Sackett's Harbor, by fishermen from the Connecticut River, about 1850. From this point they were introduced into other localities in the eastern end of the bay and between 1865 and 1875 quite a number of them were used, although, when compared with the fisheries of other lakes, the pound-net fishery can not be said to have

been important, and in 1885 there were only fourteen nets fished in the lake, nearly half of these being set for alewives* which are used in the manufacture of oil and fertilizer at Pillar Point. The absence of pound-nets in certain good fishing districts may be partially explained by the stony character of the bottom, which prevents the driving of pound-net stakes. To obviate this, the fishermen have invented a movable trap-net, similar in every respect to the pound, except that it is smaller, is held in position by means of stones and floats, and its bowl has a top of netting to prevent the escape of fish.

These nets are set in different localities where the fish chance to be abundant, being so arranged as to be easily moved from place to place. They are set on the bottom in water varying from 10 to 25 feet, the pot being lifted to the surface whenever it is necessary to remove the fish. The principal species obtained in them are sturgeon, whitefish, bull-heads, and wall-eyed pike. This variety of apparatus was not fished extensively, if at all, prior to 1875, since which time the fishery has grown in importance, until now over half of the entire catch of fish along the shores between Oswego and Cape Vincent is obtained in the trap-nets. At present it flourishes principally between Stony Point and Cape Vincent. No trap-nets are used west of Sodus Bay and only few west of Oswego.

Fyke-nets.—These have been employed for some years along various portions of the coast where the shore is low and swampy, or in bays where there are extensive mud-flats, and are fished chiefly for bull-heads and catfish, though small quantities of bass, yellow pike, eels, and perch are secured. At present more than a thousand are fished with more or less regularity in the waters of the lake, most of them being owned by farmers living along the shore.

Gill-nets.—Gill-nets are used along all portions of the shore, varying in size and mesh according to the kind of fish taken. The principal gill-net fisheries are for sturgeon, whitefish, and herring. The gill-net fishery for sturgeon is quite recent, though other species have been captured in this form of apparatus for many years.

Fishermen.—The fishermen as a rule are men who devote only a portion of their time to the fisheries. A majority of them are farmers living along the shores, and others are mechanics that fish only during those portions of the year when there is little employment on land. Probably the number entirely dependent upon the fisheries would not exceed fifty, though others giving a considerable portion of their time to the fisheries have in the statistics been regarded as professional fishermen.

Commercial species.—The principal species taken, in order of their importance, are bull-head (*Amiurus catus*), herring (*Coregonus artedi*), sturgeon (*Acipenser rubicundus*), wall-eyed pike (*Stizostedium vitreum*), bass (*Micropterus salmoides*), whitefish (*Coregonus clupeiformis*), eel (*Anguilla*

*Accidentally introduced with shad.

rostrata), perch (*Perca americana*), lake trout (*Salvelinus namaycush*), several species of suckers (*Catastomidæ*), and minor kinds.

The only fisheries which could be considered as separate and distinct from the general fisheries are those for sturgeon and alewives. The latter were introduced accidentally in connection with the shad by the U. S. Fish Commission about 1876. The only place where they are now extensively taken is at Pillar Point, where an oil and guano factory has been built for utilizing the supply. The sturgeon already mentioned are taken in large quantities with gill-nets and also by means of set-lines.

Season.—The fishing season begins as soon as the ice breaks up and continues till late in the fall. The principal fishing, however, with gill-nets, seines, and traps is in May and June and again in October and November. The fyke-nets are used extensively in summer. There is very little fishing during the winter months, though in Mexico Bay there is a limited amount of net fishing through the ice, and in the western end of the lake a few sturgeon are caught through the ice by means of set-lines. Winter fishing has never been extensively practised in this lake.

Legislation.—Of late years there has been a tendency on the part of the New York legislature to limit fishing in Lake Ontario to the capture of fish with hook and line, the object being to prevent any diminution in the supply. Stringent laws prohibiting the use of certain methods and apparatus have been enacted and a determined effort is being made by the State at considerable expense to enforce them. This is unquestionably interfering to a great extent with the development of the commercial fisheries of the lake, since many more persons would be engaged in them were it not for the enforcement of these measures. Those now employed in fishing for a livelihood complain that they are often seriously annoyed by the State officers, and frequently their operations for a considerable length of time are interrupted and rendered nearly abortive. They are often obliged to hide their apparatus and to fish it only at night or at such other times when there is little fear of detection, otherwise the gear would be confiscated and a heavy penalty imposed. Cases are not infrequent where fishermen have had their apparatus destroyed and have been heavily fined and imprisoned for illegal fishing.

The fish trade.—At Sacket's Harbor, Cape Vincent, and Chaumont dealers have located for the purpose of purchasing and distributing the catch of the fishermen in the eastern end of the lake. Most of the fish caught in the vicinity of these places are brought in by the fishermen, but sail-boats owned by the dealers are sent to collect them in places more remote. In the portion of the lake between Stony Point and Niagara River the fishing is largely for local supply, many catching only fish enough for their own tables and those of their neighbors. Those fishing more extensively ship much of their catch to cities in other portions of the state, including Syracuse, Buffalo, and New York, though

a large percentage is sold to peddlers who distribute the fish through adjacent small villages and farming communities.

Salting, smoking, and freezing of fish.—Nearly all of the fish are sold fresh, if we except the herring taken in gill-nets by the fishermen of Chaumont Bay, who salt their fish and sell to the dealers or ship into the interior.

Smoking has never been extensively practised, and in 1885 no fish were so treated by fishermen or dealers. The first artificial freezing of fish on the lake was at Sacket's Harbor in 1883, and in 1885 a second refrigerator was built at Chaumont, the object being the same here as elsewhere, namely, to retain the fish until such time as the price will warrant their shipment.

Prices of fish.—The price of fish caught in Lake Ontario, owing to the nature of the fishing and trade, averages higher than in any of the other lakes. This is explained by the fact that there are only four dealers on the entire lake, and that the bulk of the fish are sold by the fishermen directly to the consumer or to peddlers, who can usually afford to pay a good price. The demand, moreover, is usually in excess of the supply, while the nearness to New York and the excellent shipping facilities give an outlet for any surplus, so that there is seldom, if ever, an overstock.

The average prices during 1885 were, for whitefish, 5 to 6 cents per pound; trout, 5 cents; sturgeon, 4 to 6 cents; herring, 3 to 4 cents; bull-heads, 3 to 4 cents; eels, 3 to 4 cents; pike and pickerel, 4 cents; and bass, 4 cents.

General statistical summary.—The following tables show in detail the extent of the fisheries of Lake Ontario in 1885:

Table of persons employed in the fisheries of Lake Ontario in 1885.

Section.	Professional.	Semi-professional.	Shoresmen and preparators.	Total.
Youngstown and vicinity, Niagara County, New York	13	7		20
Wilson, Niagara County	16	10		26
Olcott, Niagara County	8	14		22
Orleans County	4	18		22
Monroe County, between western county line and Braddock's Point	8	14		22
Monroe County, between Braddock's Point and Charlotte	26	27		53
Irondequoit Bay and vicinity, Monroe County	10	12		22
Wayne County, from county line to Big Sodus Bay	11	36		47
Wayne County from East Bay to county line	5	11		16
Little Sodus Bay and vicinity, Cayuga County	11	6		17
Oswego and vicinity, Oswego County	8	10		18
Oswego County, from Nine-mile Point to Port Ontario		6		6
Port Ontario, Oswego County	10	14		24
Oswego County, north of Port Ontario	15	21		36
Jefferson County, from county line to Stony Point	13	6		19
Stony Island and Galloo Island, Jefferson County	15			15
Henderson Bay, Jefferson County	2	8		10
Black River Bay, and off Pillar Point, Jefferson County	24	32	10	66
Chaumont Bay, Three-mile Bay, and off Point Peninsula	21	36	7	64
Vicinity of Cape Vincent, Jefferson County	44	9	22	75
Total	264	297	39	600

Table of apparatus and capital employed in the fisheries of Lake Ontario in 1885.

Section.	Collecting steamers.		Sail and row boats.				
	No.	Value.	Sail collecting boats.	Gill-net boats.	Other boats.	Total boats.	Value.
Youngstown and vicinity, Niagara County, N. Y	......	......	......	7	6	13	$371
Wilson, Niagara County	......	......	......	10	17	27	765
Olcott, Niagara County	......	......	......	3	11	14	405
Orleans County	......	......	......	2	15	17	324
Monroe County, between western county line and Braddock's Point	......	......	......	3	13	16	306
Monroe County, between Braddock's Point and Charlotte	......	......	......	7	35	42	850
Irondequoit Bay and vicinity, Monroe County	......	......	......	2	9	11	230
Wayne County, from county line to Big Sodus Bay	......	......	......	8	41	49	1,200
Wayne County, from East Bay to county line	......	......	......	1	12	13	220
Little Sodus Bay and vicinity, Cayuga County	......	......	2	8	8	18	1,430
Oswego and vicinity, Oswego County	1	$300	......	3	10	13	307
Oswego County, from Nine-Mile Point to Port Ontario	......	......	......	3	3	6	100
Port Ontario, Oswego County	......	......	......	10	18	28	990
Oswego County, north of Port Ontario	......	......	......	7	24	31	960
Jefferson County, from county line to Stony Point	......	......	......	8	10	18	490
Stony Island and Galloo Island, Jefferson County	......	......	......	18	......	18	885
Henderson Bay, Jefferson County	......	......	......	3	9	12	330
Black River Bay and off Pillar Point, Jefferson County	1	4,500	1	25	23	49	1,570
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	......	......	2	23	8	33	1,585
Vicinity of Cape Vincent, Jefferson County	......	......	1	20	16	37	2,330
Total	2	4,800	6	171	288	465	15,648

Section.	Gill-nets.						
	Sturgeon.		Whitefish and trout.		Herring.		Value.
	No.	Length.	No.	Length.	No.	Length.	
		Feet.		*Feet.*		*Feet.*	
Youngstown and vicinity, Niagara County, N. Y	114	18,810	5	825	57	9,400	$860
Wilson, Niagara County	247	40,755	246	40,590	159	26,235	3,115
Olcott, Niagara County	102	16,830	11	1,815	55	8,960	837
Orleans County	......	......	42	6,930	74	12,120	510
Monroe County, between western county line and Braddock's Point	30	4,920	21	3,465	100	16,000	765
Monroe County, between Braddock's Point and Charlotte	......	......	75	16,420	152	25,000	1,210
Irondequoit Bay and vicinity, Monroe County	......	......	10	2,537	15	4,950	230
Wayne County, from county line to Big Sodus Bay	10	3,300	157	54,120	98	31,268	1,501
Wayne County, from East Bay to county line	......	......	4	1,320	......	......	20
Little Sodus Bay and vicinity, Cayuga County	7	3,960	48	15,080	......	......	334
Oswego and vicinity, Oswego County	......	......	93	35,473	20	8,250	575
Oswego County, from Nine-Mile Point to Port Ontario	......	......	......	......	10	4,125	50
Port Ontario, Oswego County	93	32,501	157	57,905	42	13,800	1,380
Oswego County, north of Port Ontario	87	34,640	76	29,696	40	13,200	1,256
Jefferson County, from county line to Stony Point	55	18,150	22	9,260	41	13,530	860
Stony Island and Galloo Island, Jefferson County	309	101,573	35	11,550	10	3,300	1,900
Henderson Bay, Jefferson County	40	13,200	16	5,280	52	14,526	619
Black River Bay, and off Pillar Point, Jefferson County	80	22,790	67	14,350	296	62,535	2,365
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	185	34,550	82	14,685	292	80,365	2,560
Vicinity of Cape Vincent, Jefferson County	503	85,140	180	17,325	......	......	2,975
Total	1,862	431,119	1,347	338,626	1,513	347,564	23,952

Apparatus and capital employed in the fisheries of Lake Ontario in 1885—Continued.

Section.	Seines.			Pound-nets, trap-nets, and fyke-nets.				Set-lines.		
	No.	Length.	Value.	Pound-nets.	Trap-nets.	Fyke-nets.	Value.	Length.	Hooks.	Value.
		Feet.						*Feet.*		
Youngstown and vicinity, Niagara County, N. Y	....	......	......	......	......	......	......	......	......	......
Wilson, Niagara County	....	......	......	......	......	......	......	240,000	16,000	$190
Olcott, Niagara County	....	......	......	......	......	......	......	168,000	11,200	100
Orleans County	6	2,064	$130	......	......	16	$130	15,000	1,000	7
Monroe County, between western county line and Braddock's Point	3	1,050	80	......	......	9	160	......	......	......
Monroe County, between Braddock's Point and Charlotte	11	4,830	242	......	......	116	1,392	......	......	......
Irondequoit Bay and vicinity, Monroe County	14	6,270	720	......	......	33	330	......	......	......
Wayne County, from county line to Big Sodus Bay	11	6,338	540	......	8	120	1,875	3,750	250	4
Wayne County, from East Bay to county line	5	1,548	130	......	5	60	882	1,500	100	3
Little Sodus Bay and vicinity, Cayuga County	5	1,815	205	......	26	22	1,145	......	......	......
Oswego and vicinity, Oswego County	....	......	......	......	......	......	......	36,400	2,460	50
Oswego, County from Nine-Mile Point to Port Ontario	....	......	......	......	......	20	210	......	......	......
Port Ontario, Oswego County	1	1,650	50	......	9	32	700	34,500	2,300	33
Oswego County, north of Port Ontario	10	15,759	1,005	......	3	126	1,679	12,000	800	16
Jefferson County, from county line to Stony Point	2	990	50	......	......	104	1,485	......	......	......
Stony Island and Galloo Island, Jefferson County	....	......	......	......	16	21	875	......	......	......
Henderson Bay, Jefferson County	....	......	......	......	1	3	60	37,500	2 500	35
Black River Bay, and off Pillar Point, Jefferson County	....	......	......	6	101	188	9,376	12,000	2,000	50
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	....	......	......	7	29	121	5,120	......	......	......
Vicinity of Cape Vincent, Jefferson County	1	330	25	1	138	53	5,620	......	......	......
Total	69	42,644	3,177	14	336	1,045	31,039	550,650	38,610	488

Section.	Value of wharves and buildings.	Value of accessories and fixtures.	Fish cars.		Cash capital.	Total capital invested in the fisheries.
			No.	Value.		
Younsgtown and vicinity, Niagara County, N. Y	$305	$35	......	......	......	$1,571
Wilson, Niagara County	255	150	......	......	......	4,475
Olcott, Niagara County	220	60	......	......	......	1,622
Orleans County	89	......	......	......	......	1,220
Monroe County, between western county line and Braddock's Point	120	20	......	......	......	1,451
Monroe County, between Braddock's Point and Charlotte	208	93	......	......	......	3,995
Irondequoit Bay and vicinity, Monroe County	225	795	......	......	......	2,530
Wayne County, from county line to Big Sodus Bay	868	262	......	......	......	6,250
Wayne County, from East Bay to county line	70	......	......	......	......	1,325
Little Sodus Bay and vicinity, Cayuga County	130	150	......	......	......	3,394
Oswego and vicinity, Oswego County	45	85	......	......	......	1,362
Oswego County, from Nine-Mile Point to Port Ontario	......	205	......	......	......	565
Port Ontario, Oswego County	1,510	425	......	......	......	5,088
Oswego County, north of Port Ontario	210	20	......	......	......	5,146
Jefferson County, from county line to Stony Point	125	20	......	......	......	3,030
Stony Island and Galloo Island, Jefferson County	1,050	......	......	......	......	4,710
Henderson Bay, Jefferson County	200	520	......	......	......	1,764
Black River Bay, and off Pillar Point, Jefferson County	3,800	1,230	150	$3,000	$5,000	30,891
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	4,160	1,600	1	10	2,000	17,035
Vicinity of Cape Vincent, Jefferson County	10,500	375	......	......	16,500	38,325
Total	24,090	6,045	151	3,010	23,500	135,749

Products of the fisheries of Lake Ontario in 1885.

Section.	Whitefish.	Herring.	Sturgeon.	Trout.	Bass.	Pike and pickerel.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
Youngstown and vicinity, Niagara County, N. Y.	....	7, 610	32, 724	....	4, 000	4, 200
Wilson, Niagara County	650	169, 000	51, 225	75	3, 000	3, 000
Olcott, Niagara County	126	27, 000	36, 790	70	1, 500	....
Orleans County	345	14, 350	....	625	10, 975	1, 500
Monroe County, between western county line and Braddock's Point	10, 900	25, 000	10, 000	1, 500	9, 300	2, 000
Monroe County, between Braddock's Point and Charlotte	1, 900	32, 950	....	....	16, 000	12, 000
Irondequoit Bay and vicinity, Monroe County	6, 200	12, 000	....	....	32, 000	10, 500
Wayne County, from county line to Big Sodus Bay	8, 040	9, 000	5, 000	....	46, 185	18, 750
Wayne County, from East Bay to county line	....	2, 000	....	....	4, 600	2, 600
Little Sodus Bay and vicinity, Cayuga County	300	....	1, 200	....	18, 300	17, 000
Oswego and vicinity, Oswego County	13, 595	....	....	....	12, 990	3, 450
Oswego County, from Nine-Mile Point to Port Ontario	....	300	....	....	7, 000	1, 000
Port Ontario, Oswego County	14, 350	1, 500	24, 065	....	300	1, 800
Oswego County, north of Port Ontario	2, 600	1, 200	12, 000	....	4, 600	4, 390
Jefferson County, from county line to Stony Point	625	4, 000	9, 870	....	500	2, 675
Stony Island and Galloo Island, Jefferson County	3, 180	9, 350	39, 300	1, 730	7, 460	13, 000
Henderson Bay, Jefferson County	2, 000	7, 100	5, 300	3, 810	2, 250	300
Black River Bay and off Pillar Point, Jefferson County	3, 100	31, 225	17, 500	....	23, 100	32, 000
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	2, 200	50, 000	11, 100	400	9, 730	35, 000
Vicinity of Cape Vincent, Jefferson County	20, 600	....	130, 900	12, 300	27, 100	104, 100
Total	90, 711	*403, 585	386, 974	*20, 510	240, 890	269, 265

*Of the herring and trout here given, 65, 345 pounds and 460 pounds, respectively, were salted by the fishermen; all other fish were sold fresh.

Section.	Bullheads and catfish.	Eels.	Miscellaneous species: perch, suckers, etc.	Total.	Value.
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	
Youngstown and vicinity, Niagara County, N. Y.	1, 600	....	800	50, 934	$2, 256
Wilson, Niagara County	2, 000	....	3, 600	232, 550	8, 000
Olcott, Niagara County	2, 500	1, 000	3, 800	72, 786	3, 252
Orleans County	6, 000	1, 300	4, 000	39, 095	2, 361
Monroe County, between western county line and Braddock's Point	9, 000	1, 200	1, 800	70, 700	2, 550
Monroe County, between Braddock's Point and Charlotte	37, 200	2, 500	12, 700	115, 250	6, 700
Irondequoit Bay and vicinity, Monroe County	31, 500	5, 500	6, 600	104, 300	11, 750
Wayne County, from county line to Big Sodus Bay	20, 650	600	120	108, 345	7, 100
Wayne County, from East Bay to county line	17, 100	4, 100	700	31, 100	1, 550
Little Sodus Bay and vicinity, Cayuga County	34, 000	1, 700	....	72, 500	3, 550
Oswego and vicinity, Oswego County	....	1, 100	2, 575	33, 710	2, 375
Oswego County, from Nine-Mile Point to Port Ontario	6, 700	500	....	15, 500	950
Port Ontario, Oswego County	16, 350	4, 350	2, 000	64, 715	3, 210
Oswego County, north of Port Ontario	44, 364	2, 712	1, 200	73, 066	3, 250
Jefferson County, from county line to Stony Point	18, 900	4, 125	1, 700	42, 395	1, 770
Stony Island and Galloo Island, Jefferson County	8, 885	....	....	82, 905	3, 340
Henderson Bay, Jefferson County	1, 200	500	....	22, 460	860
Black River Bay, and off Pillar Point, Jefferson County	74, 000	7. 650	500	189, 075	7, 250
Chaumont Bay, Three-Mile Bay, and off Point Peninsula	37, 300	5, 950	441, 000	592, 680	6, 945
Vicinity of Cape Vincent, Jefferson County	73, 000	16, 400	....	384, 400	16, 850
Total	442, 249	61, 187	483, 095	2, 398, 466	†95, 869

†This amount does not include the value of about 1,780,000 minnows, used for bait, for which $4,400 were paid.

100. THE VICINITY OF YOUNGSTOWN, NIAGARA COUNTY, NEW YORK.

General summary.—The village of Youngstown is on the right bank of the Niagara River, about a mile from its mouth. It has a good harbor, and the steamers navigating the lake touch here. The population, numbering 600, consists principally of merchants and farmers, only a few of the inhabitants being engaged in the fisheries. Several of the men fishing in the vicinity of Youngstown—off the mouth of the river and off Six-Mile Creek—are Canadians, living at Niagara, Ontario, who set their nets during the spring and fall in American waters, returning home in the summer. There is no fishing of any consequence at Youngstown itself, the fishing-grounds being from 1 to 10 miles distant. Owing to the remoteness of this locality from the places where the fish are taken, it is probable that it will never be a fishing center of very great importance. Some ill-feeling exists between the American and the provincial fishermen, because the latter have every privilege in our waters, while the former are not allowed to go over the line to the Canadian side of the lake.

Species and season.—The fishing is for sturgeon, herring, bass, perch, and pike; no whitefish or trout are caught. The season for sturgeon is in the spring and fall; herring are caught mostly in the autumn; while bass, perch, and pike are taken at all times. During the summer several hundred people fish for pleasure at the mouth of the Niagara River, catching bass, perch, pike, suckers, etc.

Statistical statement.—The number of fishermen at Youngstown in 1885 was 20, 13 being professionals and 7 semi-professionals. They used the following apparatus: Seven gill-net boats and 6 other boats, worth $371; 114 sturgeon gill-nets, with a total length of 18,810 feet, worth $565; 5 whitefish and trout gill-nets, 825 feet long, worth $25; 57 herring gill-nets, 9,400 feet in length, worth $270; and shore property and miscellaneous apparatus, worth $340; the total value of fishing property being $1,571.

The number of pounds of the different kinds of fish taken in 1885 was as follows: Sturgeon, 32,724; herring, 7,610; and miscellaneous varieties, consisting mostly of bass, pike, and perch, 10,600; the total catch being valued at $2,256.25.

Fishing at Lewiston.—At this place, which is 6 miles above Youngstown, on the Niagara River, there is a little trap fishing. The apparatus employed consists of a wooden box, sunk in the bed of the river, in which the trap of the net is placed; from this a leader is run about 50 feet into the river. The box is provided with a windlass with which to lift the net from the water. There are three such traps at Lewiston. It is said that as many as a thousand pounds of perch, sunfish, etc., are sometimes taken at a single haul. This fishery, being isolated from the lake, did not come within the scope of this investigation, and no statistical or other data are available in addition to those above given.

101. WILSON, NIAGARA COUNTY, NEW YORK.

Introductory statement.—Wilson is situated near the mouth of Twelve Mile Creek, which here expands into a good harbor of moderate proportions, on either side of which the coast is rough and rocky. The people number 700, the larger part of whom are farmers. At one time the fisheries were of primary importance, but of late years, owing to the restrictions of existing laws and in a measure to the scarcity of fish, they have fallen off considerably. In the fall of 1885, however, there was a general revival of interest in the fisheries, and there was an encouraging outlook for the spring of 1886. Nearly all the fishermen are young men of American birth.

Species and fisheries.—The catch consists of herring, sturgeon, whitefish, trout, and bass; bull-heads and pike are also taken in small quantities. Herring and sturgeon are the most abundant and important species. The herring fishery is carried on chiefly during the fall months, gill-nets, 165 feet in length and 3½ to 4 feet in depth, with a 3-inch mesh, being the apparatus used. Fishing for sturgeon begins as soon as the ice has broken up and continues throughout the entire open season; there is also some fishing during the winter, set lines being put through the ice for this purpose. Sturgeon gill-nets are 165 feet in length and 5 feet in depth, with an 11½-inch mesh, the latter being somewhat larger than the average mesh on Lake Ontario. Whitefish are taken during the spring and fall in gill-nets, with a 4½-inch mesh. Of late years whitefish have not been very abundant. The fishermen, however, expressed the opinion that the autumn of 1885 showed a very perceptible increase in the number. Trout of a superior quality are secured from April to June in gill-nets with about the dimensions of sturgeon nets, and having a 7-inch mesh.

All the nets used in connection with the fisheries at Wilson are bought in New York and Boston, except those for sturgeon, which are made at home by the fishermen.

During the period from June to October about four hundred people visit Wilson to take advantage of the fine facilities for pleasure fishing which the place affords. Bass and pike are caught off the pier and in boats, and there is some trolling with minnows.

Salt fish.—A very small percentage of the fish landed is salted. The cause of this is that there is such a great demand for fresh fish; and it is only when a fisherman can not dispose of his fish in a fresh condition that he finds it profitable to salt them. The few that are thus prepared are put up in half-barrels containing 100 pounds each.

Local and outside trade.—Six of the fishermen own horses and wagons, and go through the country selling their fish. Peddlers buy many of the herring, paying 1 cent a pound for them. The sturgeon, whitefish, trout, etc., are shipped fresh to New York and Buffalo by way of the railroad which runs within a mile of the village.

Prices to the fishermen.—The prices at which the different kinds of fish are sold are as follows: Sturgeon, 5 or 6 cents per pound; herring, 2 to 3½ cents fresh, 4 cents salted; whitefish, 6 to 8 cents; trout, bass, pike, perch, and bull-heads, 6 to 10 cents.

Statistics of men, apparatus, and products.—The number of men engaged in fishing at Wilson in 1885 was 26, 16 being professional and 10 semi-professional fishermen. They possessed the following apparatus: 10 gill-net boats and 17 other boats, worth $765; 247 sturgeon gill-nets with a total length of 40,755 feet, worth $1,210; 246 whitefish and trout gill-nets, 40,590 feet in length, worth $1,185; 159 herring gill-nets, 26,235 feet long, worth $720; 240,000 feet of set-lines, with 16,000 hooks, worth $190; and miscellaneous apparatus and shore property worth $405. The total amount invested in the fisheries was $4,475.

The catch in 1885 consisted of 169,900 pounds of herring, of which 6,500 pounds were salted; 51,225 pounds of sturgeon; 3,000 pounds of bass; 3,000 pounds of pike; 2,000 pounds of bull-heads; 650 pounds of whitefish; 75 pounds of trout; and 3,600 pounds of miscellaneous fish, including suckers, sunfish, etc.; the whole being valued at $8,000.

102. OLCOTT, NIAGARA COUNTY, NEW YORK.

Past and present importance of the fisheries.—Olcott is a town of 300 people, situated at the mouth of Eighteen-Mile Creek, which here widens into a harbor with 11 feet of water. Toward the east the coast is rough and rocky, and off Olcott the bottom of the lake is very hard and uneven, so that when pound-nets were used, a number of years ago, it was a rather difficult matter to locate the stakes. The larger part of the people are Americans by birth and farmers by occupation.

Pound-net and trap fishing, which was carried on to a considerable extent eight or ten years ago, is now prohibited, and gill-nets and set-lines alone are used. Fishermen say that fish are increasing in abundance year by year, and they desire to be granted the same privileges that are enjoyed by fishermen in other lakes.

Species, season, and fishing grounds.—Sturgeon and herring are the principal species caught; next in importance come bull-heads, bass, and eels; whitefish are very scarce, and only a few trout are taken. The fishing begins as soon as the ice breaks up and continues until the lake freezes again. Sturgeon are caught in gill-nets and on set-lines during the entire open season; the best grounds are east of the town, 1 to 3 miles from the shore. Herring, bass, whitefish, and bull-heads are taken chiefly in the spring and fall. From June to October several hundred people visit this locality for pleasure fishing. They fish with hand-lines from boats and from the pier. Olcott fishermen set their nets as far east as Thirty-Mile Point, where they meet with several fishermen from Barker's and Somerset, inland towns east of Olcott, the apparatus and catch of whom will, for convenience, be included in the statistics for Olcott.

Disposition of catch and prices received.—None of the fish landed at this place are salted. One man smokes his herring and markets them in Toronto, Canada. Nearly all the other fish are shipped by express to New York. The usual price at which sturgeon are sold is 5 or 6 cents a pound. But during the months of July and August, 1885, many fishermen were forced to cease operations owing to the very low price received for the fish. Herring bring 3 cents a pound, while bass, bull-heads, whitefish, and trout are worth from 6 to 8 cents a pound.

Statistics.—The number of fishermen in this locality in 1885 was 22, of whom 8 were professional and 14 semi-professional. They had the following apparatus: Three gill-net boats and 11 other boats, valued at $405; 102 sturgeon gill-nets, with a total length of 16,830 feet, worth $520; 11 white-fish and trout gill-nets, 1,815 feet long, worth $55; 55 herring gill-nets, 8,960 feet in length, worth $262; 168,000 feet of set-lines, with 11,200 hooks, worth $100; and miscellaneous apparatus and shore property, worth $280; the entire fishing outfit being valued at $1,622.

The catch in 1885 consisted of 36,790 pounds of sturgeon, 27,000 pounds of herring, 2,500 pounds of bull-heads, 1,500 pounds of bass, 126 pounds of whitefish, 70 pounds of trout, 1,000 pounds of eels, and 3,800 pounds of mixed fish, such as perch, suckers, etc., with a total value of $3,252.

103. ORLEANS COUNTY, NEW YORK.

The fishing centers in the county.—The coast of Orleans County is about 25 miles in length, extending in an almost due easterly direction from Thirty-Mile Point to Devil's Nose. The entire shore-line is rocky and has no good harbors. The fishing grounds are at Yates Pier, Johnson's Creek, Oak Orchard, and Troutville, Yates Pier is the fishing headquarters for the inhabitants of Yates Center, a village of 200 people, 3 miles from the lake. The locality is also visited occasionally by fishermen from Wilson and Olcott. Johnson's Creek is 5 miles east of Yates Pier. The fishing off its mouth is carried on by fishermen from Kuckville, a small village on the creek, about 2 miles from the lake. Oak Orchard is a community of about 100 people at the mouth of Oak Orchard Creek. It is a port of entry. Off the Government pier the water is 13 feet deep; there is a bar, however, covered with only 8 feet of water, and the harbor is fast filling up. Carlton is the post-office of Oak Orchard, and is a mile to the south. Ten miles farther east is Troutville, a village of 100 people, mostly farmers. A number of years ago it was a fishing center of some importance, but at the present time there are no regular fishermen here and the fisheries are carried on almost exclusively by men from the inland towns of Kendall, East Kendall, and Kendall Mills.

All of the places previously mentioned are favorite resorts for anglers during the summer months; at Oak Orchard and Troutville there are hotels for the accommodation of sportsmen and pleasure-seekers.

Most of the farmers living on or in the vicinity of the lake have nets with which they catch fish for home consumption.

Apparatus used.—Gill-nets and set-lines are the apparatus with which most of the fish are caught; seines and fyke-nets are employed in small numbers, although their use is prohibited by the state authorities.

Season for different species.—No sturgeon are caught at any of the fishing centers in Orleans County. Herring and bass are the most abundant species; next in order come bull-heads and pike; whitefish and trout are scarce. Fishing for herring is carried on only in the fall; the other kinds of fish are taken at all times, but chiefly in the spring and fall.

Statistics of fisheries.—There were in Orleans County in 1885, 4 professional and 18 semi-professional fishermen, with 2 gill-net boats and 15 other boats, valued at $324; 42 whitefish and trout gill-nets, 6,930 feet long, worth $185; 74 herring gill-nets, 12,120 feet long, worth $355; 6 seines, 2,064 feet in length, valued at $130; 16 fyke nets, worth $160; 15,000 feet of set-lines, with 1,000 hooks, worth $7; and miscellaneous apparatus and shore property, worth $89. The total value of fishing property was $1,220.

The catch in 1885 amounted to 14,350 pounds of herring, 10,975 pounds of bass, 6,000 pounds of bull-heads, 1,500 pounds of pickerel, 625 pounds of trout, 345 pounds of whitefish, and 5,300 pounds of eels, perch, suckers, etc.; of the herring, 1,000 pounds were salted. The value of the catch was $2,361.

104. MONROE COUNTY, NEW YORK, BETWEEN THE WESTERN COUNTY-LINE AND BRADDOCK'S POINT.

Fishing centers and grounds.—The coast-line of Monroe County between these points is about 11 miles in length, and is frequently broken by boulders and rocky ledges. There are no fishing towns immediately on the lake shore. The hamlets of Hamlin Center, North Hamlin, East Hamlin, and North Parma, which are the post-offices of most of the fishermen, are from 1 to 6 miles from the lake, adjacent to the railroad, and contain from 100 to 250 people each. The principal fishing grounds are at or near the mouth of Sandy Creek, about 6 miles from Troutville. Three miles east of this creek there are excellent seining grounds, which are not used because of the law prohibiting seine-fishing. Two miles farther east is a favorite resort for anglers; and the place is noted for its good bass fishing.

The fishermen.—A majority of the people engaged in the fisheries are farmers, who live on or near the lake, and fish for their own use, or for profit during dull times on the farm. Most of the fish not needed for home use are sold to peddlers, who scour the coast-line for fresh fish and supply the communities remote from the lake. Eight men in 1885, however, were dependent on the fisheries for a livelihood.

Apparatus.—This consists principally of gill-nets, with a few fykes and seines, the use of which depends upon the proximity of the game constable. The whitefish and trout gill-nets have a 6-inch mesh, the sturgeon nets an 11-inch mesh, and the herring nets a 3-inch mesh. The fykes vary in size from 4½ to 10 feet for the diameter of the main hoops. The dimensions of the seines are 410 by 10 feet.

Principal species.—The kinds of fish caught are sturgeon, herring, whitefish, bass, bull-heads, trout, pickerel, and perch. There is also a species allied to the whitefish, a little larger than the herring, which is locally abundant, and is known by the fishermen as the siscowet or silver whitefish; the same fish is found in numbers at Oswego, among other places, but is not identical with the siscowet of Lake Superior, which is a variety of trout (*Salvelinus*).

Statistical statement.—The number of fishermen in this section in 1885 was 22. They had the following outfit: 3 gill-net boats and 13 other boats, worth $306; 30 sturgeon gill-nets, worth $150; 21 whitefish gill-nets, worth $120; 100 herring gill-nets, worth $495; 3 seines, worth $80; 9 fyke-nets, worth $160; other apparatus and shore property, worth $140. The amount invested in the fisheries was $1,451.

The fish taken in 1885 comprised 25,000 pounds of herring, 10,900 pounds of whitefish, 10,000 pounds of sturgeon, 9,300 pounds of bass, 9,000 pounds of bull-heads, 1,500 pounds of trout, and 5,000 pounds of perch, pickerel, suckers, eels, etc.; the total catch being valued at $2,500.

105. MONROE COUNTY, NEW YORK, BETWEEN BRADDOCK'S POINT AND CHARLOTTE.

Physical characteristics of the section.—Between Braddock's Point on the west and Charlotte on the east, a distance of 7 or 8 miles, the sandy shore is broken by a series of five deep indentations—Braddock's Bay, Cranberry Pond, Long Pond, Buck's Pond, and Round Pond. These bodies of water are from one-half a mile to 2 miles long and average about three-quarters of a mile in width. The depth of water varies from 4 feet in Round Pond to 13 feet in Cranberry Pond. Cranberry Pond and Long Pond, and Buck's Pond and Round Pond are connected, during a portion of the year at least, by narrow channels.

Angling.—This is the only kind of fishing sanctioned in these ponds. They are favorite resorts for pleasure parties from Rochester and elsewhere in the state, and are carefully watched by the game constables and sporting clubs, and net and trap fishing, except illicitly at night, is pretty thoroughly broken up. As in nearly every other locality on Lake Ontario, the commercial fishermen and the laws are at variance, and a good deal of seining and fyke-netting under cover of darkness is to be expected. At Long Pond there is a good hotel kept up by sportsmen, nearly a thousand of whom visit the place annually.

Fishermen.—Most of the people in the vicinity of these bodies of water are farmers, who fish to some extent at certain seasons. North Greece, a village of 250 people, about 6 miles from the lake, is the post-office for the people near Braddock's Bay and the three western ponds, while Mount Read is the post-office of those living in the vicinity of Round Pond.

Charlotte and its fisheries.—Charlotte is on the west bank of the Genessee River, at its mouth, about 8 miles from Rochester. From each side of the mouth of the river a pier extends three-quarters of a mile into the lake. East of the town the shore is sandy, and it is here that the fishermen haul their seines; to the west the beach is made up of stones and gravel. Charlotte has about 1,000 inhabitants and is growing rapidly. It is a great place of summer resort—the Coney Island of Rochester—and some very fine hotels and cottages were in course of construction in the fall of 1885. The fishery interests are of comparatively little importance, and the business is carried on at the risk of imprisonment and seizure of property. It is asserted that many tons of fish could be taken here annually and that a flourishing industry could be established, were it not for the law.

A small Canadian vessel laden with fish for Rochester stops at Charlotte about once a week.

Kinds of fish taken.—The species caught in this section of the lake are principally herring, bull-heads, bass, pickerel, whitefish, perch, sunfish, and eels. Several fishermen expressed the belief that whitefish were becoming more abundant. The average weight of the specimens caught was about 6 pounds, although numbers of fish weighing 12 or 13 pounds were secured off Long Pond in 1885.

Disposition of catch.—Most of the fishermen sell their fish to peddlers; a few dispose of them directly to customers in the villages and towns near the lake. The few fish salted are herring, for home consumption.

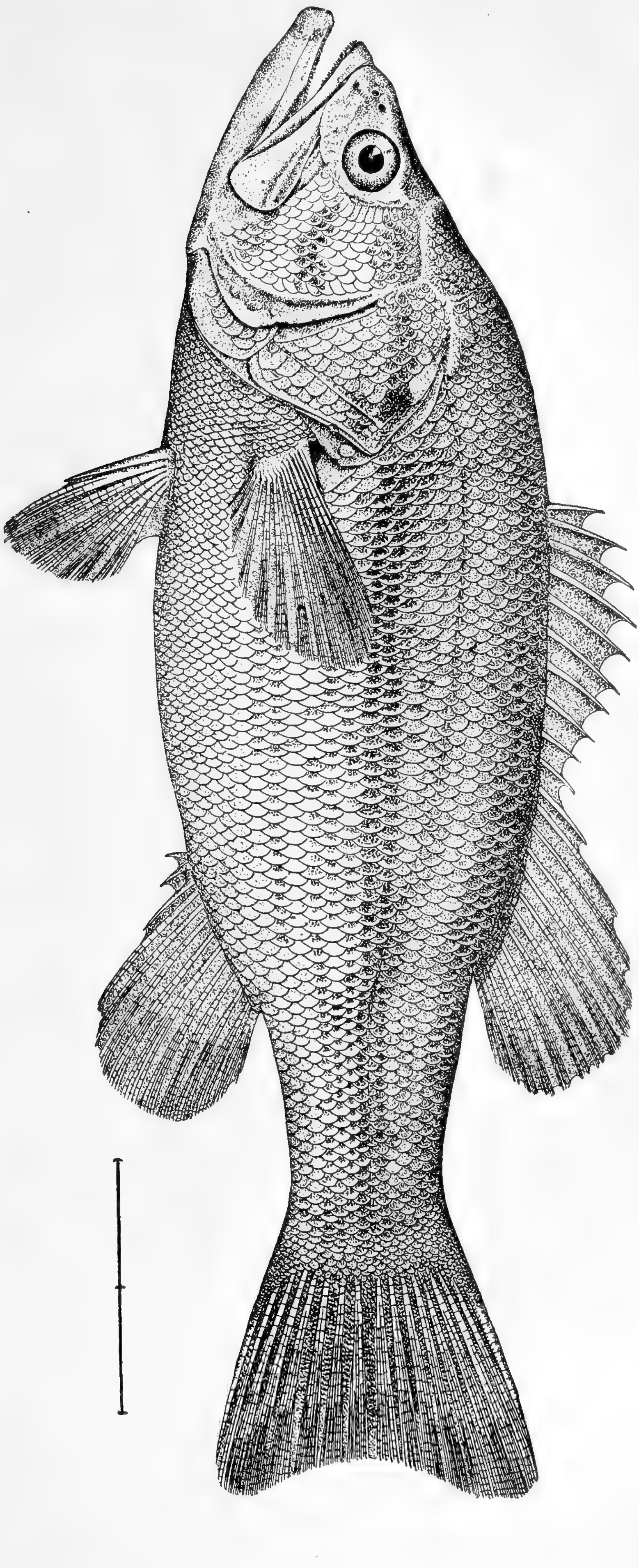
Summary.—In 1885 there were 53 men engaged in fishing in this section, of whom 26 were professional and 27 semi-professional fishermen. The apparatus consisted of 42 boats; 75 whitefish and trout gill-nets, 16,420 feet in length; 152 herring gill-nets, 25,000 feet in length; 11 seines, 4,830 feet in length; 116 fyke-nets, and miscellaneous apparatus and shore property, the total value of all of which was $3,995.

The following was the catch in 1885: 37,200 pounds of bull-heads, 32,950 pounds of herring, 16,000 pounds of bass, 12,000 pounds of pickerel, 1,900 pounds of whitefish, and 15,200 pounds of mixed fish, such as perch, eels, suckers, and sunfish. Five half-barrels or 500 pounds of herring were salted. The total value of the catch was $6,700.

106. IRONDEQUOIT BAY AND VICINITY, MONROE COUNTY, NEW YORK.

The bay and its surroundings.—Irondequoit Bay is 4 miles east of Charlotte and 6 miles from Rochester. It extends due north and south, and is 6 miles long and about a mile wide. The shores are high and rocky, except at the northern end, where a narrow strip of sand sepa-

PLATE XLIII.



LARGE-MOUTHED BLACK BASS (*Micropterus salmoides*).

rates the bay from the lake. A channel only 30 feet broad, over which is a bridge, connects the two bodies of water. Towards the middle of the bay the water becomes quite deep, varying from 5 to 13 fathoms. Pierce's Station, the railroad center and post-office of the neighborhood, is on the east side of the bay near its mouth. Directly opposite, on the west side, is the little summer resort of Sea Breeze.

Fish and fishing in the bay.—The state fish commissioners have spent much time and money in stocking Irondequoit Bay, and have made it one of the largest and finest localities for pleasure fishing in the world. The water teems with fine bass and pickerel, large perch and bull-heads, and other minor varieties, and it is estimated that twenty-five thousand sportsmen and anglers visit the bay annually. Live bait is used almost exclusively, and quite a business in minnows has been established on the bay; there are twelve dealers who claim to sell $200 worth of minnows each during some seasons, this sum representing over one million minnows. Seine, net, and trap-fishing is prohibited by law, and the game constable is kept thoroughly occupied in carrying out the provisions of the statutes. Many seizures of fishing apparatus occur, but nevertheless numbers of fyke-nets are set and seines hauled on dark and stormy nights.

Other fishing-grounds.—On the sand-bar between Pierce's Station and Sea Breeze large quantities of fish have been landed in past years. At the present time there are five men who live here in their huts and fish from May to November, using gill-nets, fykes, and seines. In 1870 and prior thereto, when pound-nets were used off Pierce's Station and Irondequoit Bay, large numbers of whitefish were taken; of late years the fish have been very plentiful, but only comparatively small quantities have been caught. There is a little fishing carried on at Nine Mile Point by men from Webster, a small inland village. The fish are sold to peddlers and to the keepers of hotels at the mouth of the bay. None of the fish are salted or smoked.

Extent of commercial fisheries.—In 1885 there were 22 fishermen here, 10 of whom were professional and 12 semi-professional. The outfit was made up as follows: 2 gill-net boats and 9 other boats; 10 whitefish gill-nets, 2,537 feet in length; 15 herring gill-nets, 4,950 feet in length; 14 seines, 6,270 feet in length; 33 fyke-nets, and miscellaneous and shore property. The total value of the apparatus was $2,530.

The catch in 1885, including the fish taken by anglers in Irondequoit Bay, amounted to 31,500 pounds of bull-heads, 32,000 pounds of bass, 12,000 pounds of herring, 10,500 pounds of pike, 5,500 pounds of eels, 6,200 pounds of whitefish, 6,600 pounds of perch and suckers, and 240,000 minnows used for bait; the total value being $11,750.

107. WAYNE COUNTY, NEW YORK, FROM THE WESTERN COUNTY-LINE TO AND INCLUDING BIG SODUS BAY.

Principal fishing centers.—The coast line of Wayne County, west of Big Sodus Bay, is about 22 miles in length. Midway the strip, at the mouth of Salmon Creek, is Pultneyville, a town of 500 people, the larger number of whom are farmers. About 1875 it was a fishing center of considerable importance, but ten years later most of the fishing was done by pleasure parties. Eel-spearing on quiet nights by the light of a jacklamp engages the attention of perhaps a dozen people, but beyond this there is no regular fishing of any consequence at this place. West of Pultneyville, about 4 miles from the lake, are the villages of Lake Side and Furnaceville, which have a population of 200 each, and are the post offices of the fishermen on the adjacent shore of the lake. The principal fishing-ground is off Bear Creek, where, as at Pultneyville, there is some spearing of eels. Along the coast, between Pultneyville and Sodus Point, there is a good deal of fishing, especially off Salmon Creek, 2 miles west of the point, where whitefish, among other species, are taken in considerable numbers.

Big Sodus Bay and its fisheries.—This bay is 5 miles long, and has an average width of 2 miles, although at its mouth it is 3½ miles wide. The depth of water is from 3½ to 7 fathoms. Prior to 1879 or 1880 pound-nets and other nets were used extensively in the bay, but since that time no net or trap fishing has been permitted. On the shores of the bay are two large hotels, and several parties hire boats to the anglers by whom the place is patronized during the summer. At the west side of the mouth of the bay is Sodus Point, a community of 600 people, who are chiefly farmers and mechanics. The harbor, which is in the bay, is one of the finest on the lake, and is kept in good condition by the government. There are a railroad, grain elevators, and large coal docks in the place, and the largest steamers can enter and transfer their cargoes. On the east side of the mouth of the bay is Lake Bluffs, a camp-meeting ground, with hotels and cottages. Fishing is carried on principally by anglers. Port Glasgow, at the head of the bay, is a favorite place with sportsmen, who use trolling-lines and catch numbers of bass, bull-heads and pike. Three miles from the lake on the east side of the bay is Lummisville, a hamlet of 100 people, mostly farmers, who fish only for their own use. Off Sodus Bay the bottom of the lake is very hard and uneven, and when pound-nets were employed it was difficult to set the stakes. At the present time the fishing-grounds are 3 to 5 miles from the shore. Sodus Point at one time had the reputation of being one of the very finest fishing localities on the lake. It was particularly noted for the excellent seining-grounds in the immediate vicinity.

Kinds of apparatus and when used.—The apparatus consists of whitefish, herring, and sturgeon gill-nets, seines, trap-nets, fyke-nets, and a

few set-lines and spears. The traps, fykes, and spears are employed more or less at all seasons, while the nets and seines are fished only during the spring and fall.

Species occurring in this section.—Bass, bull-heads, pike and pickerel, herring, whitefish, sturgeon, eels, and a very few suckers are the kinds of fish caught. Whitefish of large size are taken, being especially abundant off Sodus Bay, where the average weight of the fish is 6½ pounds. A few sturgeon are taken 2 miles west of Sodus Point, off Salmon Creek. No trout were landed in 1885, although about 1,600 pounds were secured in the previous year.

Disposition made of catch.—A small proportion of the fish are reserved for home consumption, and a few are shipped to New York, but the larger part of the catch is sold to peddlers and to the people of the inland towns and villages near the lake. Only one man salted his fish in 1885, six half barrels of herring being the quantity thus prepared.

Statistics.—The number of men engaged in the fisheries was 47, 11 being professional and 36 semi-professional fishermen. Their apparatus consisted of 8 gill-net boats and 41 other boats; 10 sturgeon gill-nets, with a total length of 3,300 feet; 157 whitefish gill-nets, 54,120 feet long; 98 herring gill-nets, 31,268 feet long; 8 trap-nets; 11 seines, 6,338 feet long; 120 fyke-nets; 3,750 feet of set-lines, with 250 hooks; and shore property and other apparatus. The capital invested in boats was $1,200; in gill-nets and seines, $2,041; in traps, fykes, and lines, $1,879; and in shore property and miscellaneous apparatus, $1,130, giving $6,250 as the total value of fishing property.

The number of pounds of the different kinds of fish taken in 1885 was: Bass, 46,185 pounds; bull-heads, 20,650 pounds; pike and pickerel, 18,570 pounds; herring, 9,000 pounds; whitefish, 8,040 pounds; sturgeon, 5,000 pounds; eels, 600 pounds; suckers, etc., 120 pounds. Six hundred pounds of the herring were salted. To the above should be added 50,000 minnows used for bait. The total value of the products was $7,100.

108. WAYNE COUNTY, NEW YORK, BETWEEN EAST BAY AND THE COUNTY-LINE.

Fisheries of East Bay.—This section of coast is 10 miles in length, and is very rocky. Two miles from Big Sodus Bay is a small indentation, about three-quarters of a mile long and half a mile wide, known as East Bay, which is from 5 to 8 feet deep. It is the principal fishing-ground of the farmers and others in the vicinity and of the inhabitants of Huron and North Huron, small post-offices to the south. The fishing is of no very great importance; a few seines are drawn, and trap-nets and fyke-nets set in the bay in violation of the law, and there is a little pleasure fishing during the summer, but beyond this nothing is done. A party of men fish throughout the entire year, using fykes with leaders and wings, a style of net nearly unknown elsewhere in Lake On-

tario, and catching bull-heads almost exclusively. The latter are the most abundant fish in the bay; there are also pike, perch, and eels.

Port Bay and vicinity.—Port Bay is 2 miles farther east and is twice the size and four or five times the depth of the preceding. On its shores are hotels for the accommodation of anglers, who, to the number of three hundred, visit the place annually and fish for bass and pike. The post-offices in the vicinity are Wolcott and North Wolcott, which are 5 and 3 miles, respectively, from the bay. The people in the vicinity are all farmers, who take fish chiefly for their own use; a few sell to peddlers, and a smaller number ship to Rochester. Only one fisherman salted any of his catch. The apparatus is similar to that in East Bay, with the addition of a small number of gill-nets and set-lines. There is a little fishing carried on at the mouth of Red Creek, 2 miles east of the bay, by a fisherman from North Wolcott.

Men, apparatus, and catch in 1885.—Sixteen men, including 5 professional fishermen, were employed on this division of the coast. Their outfit consisted of 13 boats; 4 whitefish gill-nets, with a total length of 1,320 feet; 5 seines, 1,548 feet long; 5 trap-nets; 60 fyke-nets; 1,500 feet of set-lines, with 100 hooks; and miscellaneous and shore property, the value of all of which apparatus was $1,325.

The catch included 17,100 pounds of bull-heads, 4,600 pounds of bass, 4,100 pounds of eels, 2,600 pounds of pike and pickerel, 2,000 pounds of herring, and 700 pounds of perch; of the herring, 1,000 pounds were salted. The total value of the catch was $1,550.

109. LITTLE SODUS BAY AND VICINITY, CAYUGA COUNTY, NEW YORK.

Topography of the section.—Little Sodus Bay is about a mile from the western line of Cayuga County. It is 2½ miles long and a mile wide, with 4 to 6 fathoms of water. Near the head of the bay is the village of Fair Haven, the post-office of the people residing in vicinity of the southern end of the bay. There is no harbor here, but at North Fair Haven there is a good port with 6 fathoms of water. The place is a railroad terminus, with large coal and ore docks, and wharves at which the largest steamers can lay.

Between this bay and Oswego, a distance of 13 miles, the shore is rough and stony, and affords no spawning grounds for whitefish, but excellent feeding-grounds are said to exist off the mouth of the bay.

Fishing in the bay and vicinity.—The bay is a favorite resort for anglers who come hither in large numbers during the season and fish from boats hired from the keepers of hotels, three of which are on the shores of the bay. The water abounds in bass, bull-heads, and pike, the bass being particularly numerous; sturgeon and eels also occur. A short time ago Little Sodus Bay yielded a great many fish, but within the last few years there has been a falling off in the catch owing to the law forbidding the use of traps and nets, and the fishermen have been getting fish from Canada to supply their orders. Three men from Oneida Lake fish

in the bay with sturgeon and trap nets during a part of the year. In the lake off the bay whitefish and sturgeon are taken in small quantities. There is a little fishing in Blind Sodus Bay, west of Little Sodus Bay, pike, bass, and bull-heads being the varieties caught. The fishermen sell most of their fish to peddlers, shipping only a few to Rochester and Syracuse. No fish were salted in 1885.

Statistical enumeration.—Eleven professional and 6 semi-professional men were engaged in the fisheries at Little Sodus Bay in 1885. The apparatus used consisted of 8 gill-net boats, 8 other boats, and 2 collecting boats; 7 sturgeon gill nets, 3,960 feet in length; 48 whitefish gill-nets, 15,080 feet long; 26 trap-nets; 5 seines, 1,815 feet long; 23 fykes; and wharves and other property. The capital invested in boats was $1,430; in nets and seines, $539; in traps and fykes, $1,145; in shore property, etc., $280; the total value of fishing property being $3,394.

The amount of fish taken in 1885 was 34,000 pounds of bull-heads, 18,300 pounds of bass, 17,000 pounds of pike, 1,700 pounds of eels, 1,200 pounds of sturgeon, and 300 pounds of whitefish, the value of the entire catch being $3,550.

110. OSWEGO AND VICINITY, OSWEGO COUNTY, NEW YORK.

Fishery interests of Oswego.—This city, the center of trade on Lake Ontario, is at the mouth of the river of the same name. Its 24,000 inhabitants are mostly engaged in mercantile pursuits. The fishery industry is comparatively insignificant, only about half a dozen men having such a vocation, and these not fishing regularly. The people of Oswego are not dependent on the fisheries of the vicinity for their supply of fish, but get the latter from Erie, Buffalo, and Sackett's Harbor, through dealers who buy Canadian products chiefly and hence it appears that nearly all of the fish eaten in Oswego come from Canada. The great antipathy felt by the inhabitants of Oswego toward the regular fishermen of the place has had the effect of indirectly throwing the fish trade of the place into Canadian hands.

Fishing grounds.—The best grounds are 2 to 5 miles in the lake, north and east of Oswego; there is also some fishing in the river. On the shore near Southwest Oswego, a small village whose inhabitants are principally farmers, there are good bass fishing grounds at Lewis' Bluffs. About 1,500 pounds of bass were taken here in 1884, the fish averaging $1\frac{1}{2}$ pounds in weight. Three miles west of the Bluffs, at the mouth of Eight-Mile Creek, there is a little fishing in the spring, and one of the farmers in the neighborhood hauls a small seine in the creek.

Angling.—Pleasure fishing at Oswego is participated in by a large number of people. The season begins about the first of June and continues until September. Bass and pike are caught with hand lines off the piers and from boats, minnows being used for bait.

Commercial fishing.—This is done with gill-nets and set-lines. The latter were very extensively used at one time, but are now almost discarded. Gill nets are fished chiefly for whitefish, there being no herring, while the other species are taken on set-lines. A small steamer valued at $300 is used to collect the fish on the grounds.

Species.—Whitefish are the most important and abundant fish caught in this section. There is a small variety called by the fishermen "siscowet" and "silver whitefish," already mentioned as occurring in Monroe County, which is quite plentiful. It weighs from 1½ to 2 pounds and sells almost as readily as the common whitefish. Bass and pike rank next as regards number and value. Eels, perch, mullets, and a few shad are also secured. No sturgeon, herring, or bull-heads were taken in 1885. The fishing season is the spring and fall, only anglers fishing during the summer.

Statistical statement.—Eighteen men were engaged in fishing in this region in 1885, 8 of whom were professional fishermen. They used the following apparatus: 1 collecting tug, 3 gill-net boats, and 10 other boats; 93 whitefish gill-nets, 35,473 feet long; 20 herring gill-nets, 8,250 feet long; 36,400 feet of set-lines, with 2,460 hooks; together with shore property and accessories. The total capital invested in the fisheries was $1,362.

The catch for 1885 was 13,595 pounds of whitefish, 12,990 pounds of bass, 3,450 pounds of pike, 1,100 pounds of eels, 1,900 pounds of mullets, 656 pounds of perch, and a few shad; 30,000 minnows were used for bait. The total value of fish taken was $2,375.

111. OSWEGO COUNTY, NEW YORK, BETWEEN NINE-MILE POINT AND PORT ONTARIO.

General remarks.—Off the shore immediately north of Oswego there is no fishing, and it is not until Nine-Mile Point is passed that any fishing communities are found. The strip of coast included within the above limits is 10 miles long, and marks the southern boundary of Mexico Bay. Two miles east of Nine-Mile Point is Point Pleasant, a place somewhat noted for its bass fishing; the bass spawn on the gravel-beds just off the Point, and anglers, to the number of 700, visit the place and fish mostly from boats. This is the only kind of fishing carried on here. At the mouth of Little Salmon Creek are fishing grounds that are worked by people connected with the life-saving station on the right side of the creek. Bass and pike are caught here by pleasure parties, minnows being used for bait. On this creek, a mile from the lake, is the village and post-office of Texas, with 200 people, all farmers, who are not now engaged in fishing. The inhabitants of Daysville, a small village 3 miles from the lake, fish off the mouth of Grindstone Creek, fykes being the apparatus used; only one man at this place is a regular fisherman, the others being farmers who depend more or less on the water for their supply of food.

Statistics of the fisheries.—The fishermen in this locality in 1885 numbered 6, none being professionals. The apparatus was as follows: 6 boats, 10 herring gill-nets, 4,125 feet long; and 20 fyke-nets. The total value of the fishing property, including shore accessories, was $565.

The catch in 1885 was 7,000 pounds of bass, 6,700 pounds of bull-heads, 1,000 pounds of pike, 500 pounds of eels, and 300 pounds of herring. Ten thousand minnows were bought from dealers and used for bait. The total catch was valued at $950.

112. PORT ONTARIO, OSWEGO COUNTY, NEW YORK.

Past and present fishery interests.—This place is situated on Salmon Creek, three-quarters of a mile from the lake. What was once a good harbor is now filled with sand, the wharves have been washed away, and the whole village has a run-down aspect. The 300 people who live here are nearly all Americans and are engaged in agricultural pursuits. There was a time when Port Ontario was a fishing center of considerable importance and a live business community; and it is thought that the increase of fish which fishermen are hoping for, and which some even predict for the near future, will restore it to its former state of activity and enterprise. The fishing grounds are at the mouth of the creek and in the lake as far as 20 miles from the shore; there is also a little seining on the smooth, sandy beach north of the town. Prior to 1880 seining was the principal mode of fishing, but since that date gill-nets have been used almost entirely, and the seining grounds are practically deserted.

Kinds of fish taken.—The whitefish is the most important species at Port Ontario. It appears to be periodical in its abundance, owing to peculiarities in its migrations the causes for which are as yet imperfectly understood. Fishermen think that the direction of the prevailing winds has some influence on the appearance and movements of the fish. In 1885 the fish taken were rather larger than those caught the previous year, and there was also a slight increase in their abundance. The spring and fall are the times when fishing for whitefish is carried on. Next in importance is the sturgeon, which is caught in gill-nets and on set-lines during the entire open season. Bull-heads and eels are plentiful. Pike, herring, and bass are not common.

Markets and prices.—The fish are sold to peddlers or shipped to New York, Syracuse, and Oswego. Only a very few herring are salted.

The prices received for fish at Port Ontario are: Whitefish, 8 cents a pound; sturgeon, 4 and 5 cents; bull-heads, 4 and 5 cents; herring, 4 cents; pike, 5 cents; eels and suckers, 3 and 4 cents.

Enumeration of men, apparatus, and catch.—There were 24 men engaged in fishing at Port Ontario in 1885, 10 being professional and 14 semi-professional fishermen. The apparatus they possessed consisted

of 10 gill-net boats and 18 other boats; 93 sturgeon gill-nets, 32,500 feet in length; 157 whitefish gill-nets, 57,905 feet in length; 42 herring gill-nets, 13,800 feet in length; 9 trap-nets; 1 seine, 1,650 feet in length; 32 fyke-nets; 34,500 feet of set-lines, with 2,300 hooks; and miscellaneous and shore property. The capital invested in boats amounted to $990; in nets and seine, $1,430; in traps, fykes, and lines, $733; in other apparatus, and wharves, etc., $1,935. The total value of the fishing property was $5,088.

The following figures show the number of pounds of each species landed in 1885: sturgeon, 24,065; bull-heads, 16,350; whitefish, 14,350; eels, 4,350; suckers, 2,000; pike, 1,800; herring, 1,500; bass, 300. Four hundred pounds of herring were salted. The total value of the catch was $3,210.

113. OSWEGO COUNTY, NEW YORK, NORTH OF PORT ONTARIO.

Fisheries of North Little Sandy Pond.—The sandy coast of Oswego County, between Port Ontario and Jefferson County, extends in a straight line for its entire length, a distance of 6½ miles. All the fishing along this shore is done in or off North Little Sandy Pond. This pond or bay is 3½ miles long and 2 miles wide, the water off the shores being from 7 to 18 fathoms deep. Communication with the lake is established by means of a channel 50 feet wide and a few feet in depth, at the southern end of the pond. About twenty-five gill-net, seine, set-line, fyke, and trap-net fishermen live on or near this body of water, and the place is also visited by people from Sandy Creek, a village of 1,100 inhabitants, 4 miles from the pond. Of late the locality has become a somewhat popular resort for anglers, who make their headquarters at the hotel at the mouth of the pond. A game club of Oswego claims the pond as a hunting ground for ducks, etc., but fishing here has not been stopped as yet. The extreme northern portion of the pond is in Jefferson County and is fished by a man from Ellisburgh, whose catch and apparatus will be included in the statistics of that county.

The narrow sand-strip which separates the pond from the lake is an excellent seining ground, but it is not used, because the fishermen fear that their seines will be seized. The fishing-grounds in the lake are directly off the pond.

Species.—Bull-heads are by far the most abundant species, spawning in immense numbers just at the mouth of the pond. Sturgeon are caught in considerable quantities with gill-nets and set-lines.

Whitefish are not plentiful, but are becoming more so. Bass, pike, and perch are fairly common in the pond, and are mostly taken by anglers. Eels, herring, and suckers complete the list.

Sale of fish.—Many of the fish are sold to peddlers; some are sent to New York, by way of Sandy Creek; while a fish-dealer at Chaumont gets the largest number. The prices vary but little from those in adjacent sections.

Statistics of the fisheries.—Fifteen professional and 21 semi-professional fishermen were engaged in this section in 1885. The apparatus consisted of 7 gill-net boats, 24 other boats; 87 sturgeon gill-nets, 34,640 feet long; 76 whitefish gill-nets, 29,696 feet long; 40 herring gill-nets, 13,200 feet long; 3 trap-nets; 10 seines, 15,759 feet long; 126 fyke-nets; 12,000 feet of set-lines, with 800 hooks; and wharves, buildings, etc. The total amount invested in fishing property was $5,146.

The relative abundance of the individual species is shown by the following figures, giving the catch for 1885: Pounds of bull-heads taken, 44,364; sturgeon, 12,000; bass, 4,600; pike, 4,390; eels, 2,712; whitefish, 2,600; herring, 1,200; perch, 1,000; suckers, 200. The total value of the fish taken was $3,250.

114. JEFFERSON COUNTY, NEW YORK, FROM THE SOUTHERN COUNTY-LINE TO STONY POINT.

Character of the shore.—The southern section of this coast is an almost unbroken sand beach, while the northern portion is rocky and uneven. To the south, a few rods inland, is the extreme upper part of Little Sandy Pond; beyond this the shore is broken by Big Sandy Creek and Pond and Stony Creek.

Settlements and fishing grounds.—There are no settlements immediately on this shore. A few miles from the lake, on the South Branch of Big Sandy Creek, is the village of Ellisburgh, which is the post-office of the people in this part of the county. The inhabitants are all farmers, some of whom engage in fishing. The mouth of Big Sandy Creek and Big Sandy Pond are the principal grounds where fishing is carried on. One man sets his nets in Little Sandy Pond. Only a very little fishing is done in the lake.

Woodville is a small community of farmers on the North Branch of Big Sandy Creek. At one time the fishery interests of the place were of considerable importance; seining, in particular, on the lake adjacent to the village was a favorite occupation for a number of people; but now the fishing interests are unimportant.

Half-way between Big Sandy Creek and Stony Creek are deserted seining grounds that were extensively worked until the year 1881, when the desirable fish became scarce.

Apparatus of capture.—Throughout this section of the lake fyke-nets are the apparatus most extensively used. The fishermen of Ellisburgh use them exclusively, and make them at home. The nets have leaders about 200 feet in length, and have a 2½-inch mesh. Many nets are left in the water during the winter, a hole being cut in the ice through which to take the fish. Gill-nets are employed in taking sturgeon, herring, and whitefish. Suckers are speared through the ice to a slight extent.

Kinds of fish caught.—Bull-heads are the most abundant fish in Big Sandy Pond and at the mouth of Big Sandy Creek. Sturgeon are

taken at the mouth of Stony Creek and in smaller numbers off Big Sandy Creek. Whitefish are scarce; only one fisherman caught any in 1885; these weighed from 1 to 2 pounds each, and were secured off Big Sandy Creek. A few herring are taken in gill-nets off the shores adjacent to Ellisburgh and Woodville. Pike, suckers, eels, perch, and bass also occur in the pond and creeks.

Extent of the fisheries.—Thirteen professional fishermen and 6 who fished during only a part of the year were engaged on this shore in 1885. They had the following apparatus: 8 gill-net boats and 10 other boats; 55 sturgeon gill-nets, 18,150 feet long; 22 whitefish gill-nets, 9,260 feet long; 41 herring gill-nets, 13,530 feet long; 104 fyke-nets; 2 seines, 990 feet long; and miscellaneous apparatus, etc. The total value of the fishing property and outfit was $3,030.

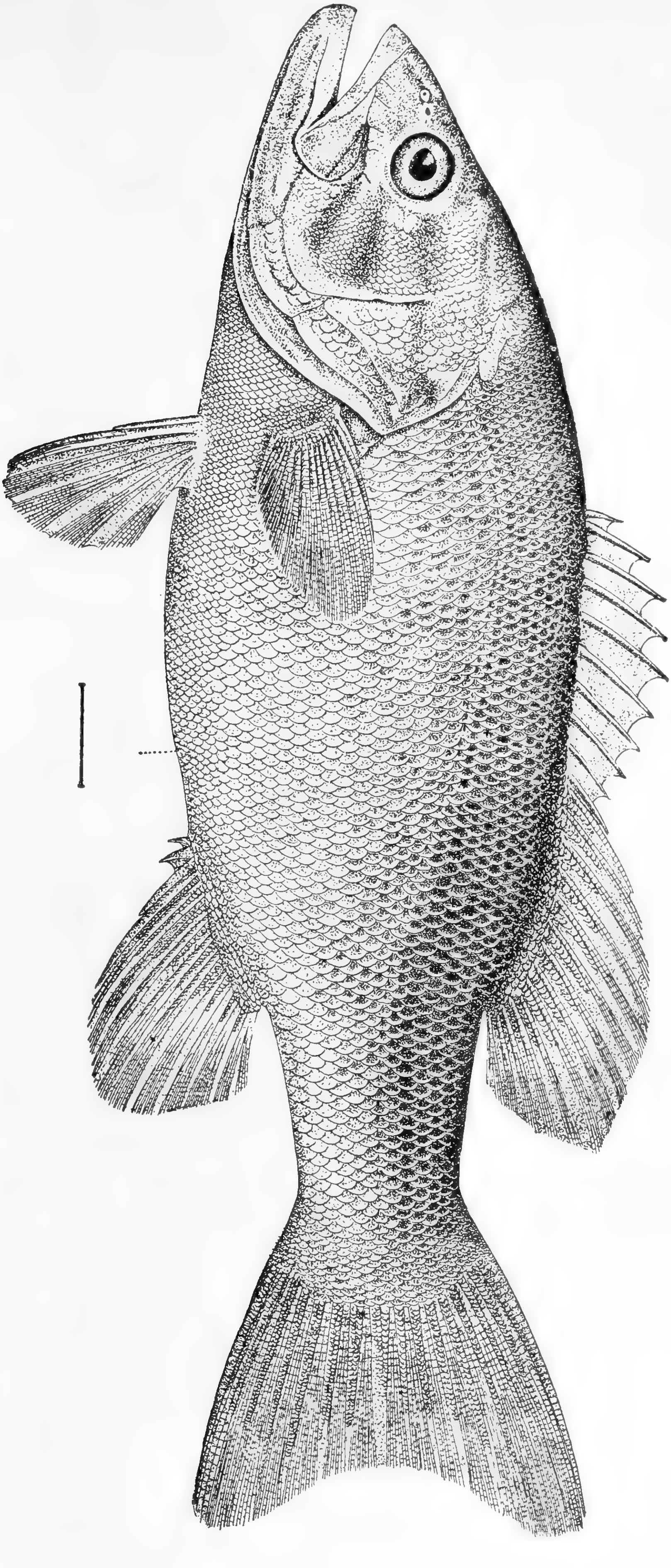
The fish landed in 1885 consisted of 18,900 pounds of bull-heads, 9,870 pounds of sturgeon, 4,125 pounds of eels, 4,000 pounds of herring, 2,675 pounds of pike, 1,000 pounds of perch, 700 pounds of suckers, 625 pounds of whitefish, and 500 pounds of bass. The total value of the catch was $1,770.

115. STONY ISLAND AND GALLOO ISLAND, JEFFERSON COUNTY, NEW YORK.

Geography of the islands.—These are large islands northwest of Stony Point, Stony Island being $2\frac{1}{2}$ and Galloo Island 6 miles from the shore. Extending lengthwise of the former island is a pond or bay 2 miles long and one-eighth of a mile wide; it has connection with the lake through a very narrow channel, which runs into Dutch John's Bay, on the northwest side of the island; the depth of water in this pond is from 8 to 27 feet. The shores of Galloo Island are low and marshy, except a portion of the northwestern side, where the woods abut on the lake. The gravel beds around these islands are supposed to be the spawning grounds of the whitefish and trout; such at least is the opinion of the fishermen. Cape Vincent, Sackett's Harbor, and Chaumont fishermen visit the fishing grounds in this locality at certain periods, and a few men, with their families, make the islands their permanent abode. There are several cottages and a boarding-house at the upper end of Stony Island at which sportsmen stop in summer. One fisherman on Galloo Island has an ice-house in which his fish are packed until a collecting boat from Chaumont comes for them.

Species and abundance.—Sturgeon are quite numerous off the islands, and are caught in gill-nets and trap-nets at all seasons when there is no ice. Whitefish are of small size but more plentiful than for some years past. Trout are fairly common. The long pond on Stony Island abounds in pike, bull-heads, and bass; these are caught only by sportsmen, however, the regular fishing for these abundant species being carried on off the shores, fyke-nets and trap-nets being used. Herring are taken in considerable numbers, and, except in the case of a small portion

PLATE XLIV.



SMALL-MOUTHED BLACK BASS (*Micropterus dolomieu*).

of the catch of one man, all were salted. A large part of the fish taken in this section are sent to dealers in Chaumont, Sackett's Harbor, and Cape Vincent, who advance supplies to the fishermen and take fish in payment.

Statistics.—There were 15 regular fishermen employed around these islands in 1885. Their apparatus comprised 18 gill-net boats; 309 sturgeon gill-nets, 101,570 feet long; 35 whitefish and trout gill-nets, 11,550 feet long; 10 herring gill-nets, 3,300 feet long; 16 trap-nets; 21 fyke-nets; and accessories and shore property. The amount invested in boats was $855; in gill-nets, $1,900; in trap-nets and fyke-nets $875; in wharves, miscellaneous apparatus, etc., $1,050; the total value of the apparatus and other fishing property being $4,710.

The amounts of the different kinds of fish landed in 1885 were 39,300 pounds of sturgeon, 13,000 pounds of pike, 9,350 pounds of herring, 8,885 pounds of bull-heads, 7,460 pounds of bass, 3,180 pounds of whitefish, and 1,730 pounds of trout. Nine thousand one hundred and fifty pounds of the herring were salted. The total value of the catch was $3,340.

116. HENDERSON BAY, JEFFERSON COUNTY, NEW YORK.

Description of the bay.—Henderson Bay is 6 miles long and from 1½ to 3 miles wide. The shores of the bay are rather uneven, but not particularly rough or rocky. The water is from 4 to 7 fathoms deep, and the bottom of the bay is of mud and sand. Henderson Harbor is at the southern end of the bay; in it, near the mouth, is Port Henderson, a village of 200 people, the majority of whom are farmers. The harbor is a favorite place of resort for anglers; the commercial fishermen, however, are few in number, owing to the great opposition to net-fishing and net-fishers, which deters many who have been extensively engaged in the fisheries in the past from again resuming the business.

Past and present forms of apparatus.—In 1875 and prior thereto there was a large number of pound-nets in the bay, and whitefish and trout were caught in great quantities, but at the present time not a pound-net is set and the fishing is carried on almost exclusively with set-lines and gill-nets. The set-lines are weighted with stones; the hook-lines or gangings are 2 feet in length, and are placed about 16 feet from one another on the ground-line or leader. Young herring are used for bait; these are blown up with air to keep them afloat, and the hook is run along the back, beginning at the tail. The bait thus prepared floats with the head upward and looks quite life-like. Sturgeon and trout are caught in this way. Gill-nets are fished for sturgeon and trout; whitefish are also taken by this means, although only one man used such nets in 1885. Only a few fyke-nets are set in the bay; in these are caught bull-heads, bass, pike, and eels. A single trap-net completes the list of apparatus.

Disposition of catch.—More than half the herring landed in 1885 were salted by the fishermen for home purposes; a small percentage of the

trout was also thus prepared. The people of Henderson and a firm at Sackett's Harbor bought most of the fresh fish.

Statistical statement.—There were 10 men engaged in fishing in Henderson Bay in 1885; of these only 2 were professional fishermen. The outfit of these men consisted of 3 gill-net boats and 9 other boats; 40 sturgeon gill-nets, 13,200 feet in length; 16 whitefish gill-nets, 5,280 feet in length; 52 herring gill-nets, 14,526 feet in length; 1 trap-net; 3 fyke-nets; 37,500 feet of set-lines, with 2,500 hooks; and shore property and accessories. The amount invested in boats was $330; in gill-nets, fyke-nets, trap-net, and set-lines, $714; in wharves, buildings, and miscellaneous apparatus, $720; the value of the entire fishing outfit being $1,764.

The following is the catch for 1885: 7,100 pounds of herring, 5,300 pounds of sturgeon, 3,810 pounds of trout, 2,250 pounds of bass, 2,000 pounds of whitefish, 1,200 pounds of bull-heads, 500 pounds of eels, and 300 pounds of pike. Of the herring 4,100 pounds and of the trout 60 pounds were salted. The total value of the fish was $860.

117. BLACK RIVER BAY AND PILLAR POINT, JEFFERSON COUNTY, NEW YORK.

Black River Bay and its fishery interests.—Black River Bay is 6 miles long and 1½ miles wide. Its upper third is shallow and almost unnavigable, while the lower part has an average depth of from 6 to 10 fathoms, the bottom being mostly mud. Dexter is a village of 400 people at the head of the bay; its inhabitants are chiefly farmers and fishermen. The good harbor at this place is rendered almost worthless by large sand-bars which make it impossible for vessels or boats drawing more than 2 feet of water to reach the village. The fishermen residing here set their nets off Pillar Point. Sackett's Harbor is the only other community of any importance on the bay; it has a fine harbor, with deep water, and is a railroad terminus. It has about 1,000 inhabitants, who are, with a few exceptions, farmers of American birth.

Pound-nets and traps.—Pound-nets were introduced into Black River Bay in 1850 by a man from Connecticut; from that time until a comparatively recent date they were almost universally employed by the fishermen. Of late, however, their use has declined and they have been so completely superseded by the smaller and cheaper trap-nets that in 1885 there were only six pounds in the bay or vicinity. The same changes are to be observed here as in all other localities in Lake Ontario in which pound-nets were formerly set.

Four men from Oneida Lake fish in the bay off Campbell's Point from May to September; they use trap-nets, which, with boats and other accessories, they send by rail to Sackett's Harbor.

Fisheries off Pillar Point.—This point is a large promontory separating Chaumont and Black River Bays. At one time the fishing-grounds off its shores were perhaps the best in the entire lake. This was about

1870. Since 1875 but little fishing has been done. At the present time, among the 700 people on the point, all of whom are farmers, there are many who were extensively and exclusively engaged in the fisheries, whose fish-houses are still standing and whose apparatus is in waiting for the time when the fish shall return in their former numbers.

Apparatus of capture.—In addition to the pound-nets and trap-nets already referred to, fyke-nets are also in common use. Gill-nets are set for sturgeon, whitefish, and herring, the most netting being devoted to the capture of the last-named species. A few set-lines are also fished.

Abundance of the different species.—Bull-heads, pike, herring, bass, sturgeon, eels, whitefish, and perch are the important species occurring in Black River Bay and off Pillar Point, the order given representing the relative number of pounds of each kind of fish taken in 1885. Herring are here called "ciscoes," and are said to have gotten the name from a peddler who, about 1830, took them through the state and sold them to the farmers and others as "Ciscoe's herring." Whitefish are very scarce, although a greater number of young fish were noticed in 1885 than for many years previously. Fishermen attribute the large decrease of whitefish and the entire absence of trout to the alewives, which have died on the spawning-grounds in immense quantities, causing other species to seek new quarters. At one time Horse Island, at the mouth of the bay, was a favorite spawning place for whitefish and trout, but the waters of this and other similar localities are now deserted, so far as the species in question are concerned.

The fish trade.—Nearly all the fish caught in this section go to Sackett's Harbor, except the few used at home by the fishermen. The latter get their twine and other supplies of the dealers, who take their pay in fish. At Sackett's Harbor four shoresmen and four preparators were employed in 1885. The wharves, buildings, and apparatus, including a steamer and a boat used to collect fish from the outlying fishing grounds, and fish-cars, were valued at $18,200. The freezing apparatus at Sackett's Harbor has a capacity of 300 tons. It is divided into four apartments, up and down which run about a dozen galvanized iron pipes that are 18 inches in diameter. These pipes are filled with ice and salt from the floor above the freezer, and a waste-pipe carries off the water accruing from the melting ice. About 400 pounds of ice and salt are required to fill each pipe. Preparatory to freezing, the fish are allowed to remain in an ice chest during one night, and are then put in boxes and placed in the freezer, where they are subjected to a temperature of 10° below zero, Fahr. The expense of freezing is about 1 cent per pound, but by holding the fish thus treated until after the fishing season or until there is a great demand for them, an advance of 2 cents per pound is obtained over the ordinary price for unfrozen fresh fish. Only from one-fifth to one-fourth of the fish handled here are taken in American waters.

Statistics.—Sixty-six men were employed in the fisheries in 1885; of these 24 were regular fishermen, 32 semi-professional fishermen, and 10 shoresmen and preparators. The apparatus used was as follows: 1 collecting tug, 25 gill-net boats, 1 collecting boat, and 23 other boats; 80 sturgeon gill-nets, 22,790 feet in length; 67 whitefish gill-nets, 14,350 feet in length; 296 herring gill-nets, 62,535 feet in length; 6 pound-nets, 101 trap-nets, 188 fyke-nets; 12,000 feet of set-lines, with 2,000 hooks; 150 fish-cars, together with wharves, buildings, and miscellaneous property. The capital invested in boats was $6,070; in gill-nets, $2,365; in pound-nets, trap-nets, and fyke-nets, $9,376; and in other apparatus, wharves, buildings, and working capital, $13,080, making a total of $30,891 invested in the fisheries.

The amount of fish taken was 74,000 pounds of bull-heads, 32,000 pounds of pike, 31,225 pounds of herring, 23,100 pounds of bass, 17,500 pounds of sturgeon, 7,650 pounds of eels, 3,100 pounds of whitefish, and 500 pounds of perch. Twelve thousand three hundred and seventy-five pounds of the herring were salted. The total value of the fish was $7,250.

118. CHAUMONT BAY, THREE-MILE BAY, AND OFF POINT PENINSULA, JEFFERSON COUNTY, NEW YORK.

Chaumont Bay.—This extends about 7 miles from east to west and 3 miles or more from north to south. The bottom is of mud and clay, and the water is from 3 to 5 fathoms deep. At the northeast end, at the mouth of Cat-Fish River, is the town of Chaumont, with 700 inhabitants, a large majority of whom are farmers. The harbor is good, with 10 to 14 feet of water. The fisheries do not amount to much, in proportion to the population. The fishermen set their nets in the bay, and also near Stony and Galloo Islands.

Three-Mile Bay.—At the northern side of Chaumont Bay, about 8 miles southeast of Cape Vincent, Three-Mile Bay extends 2 miles inland, and at its head is the village of the same name. Its people are farmers and fishermen. At one time some ship-building was done here, but since the bay became obstructed with mud this industry has been discontinued; only small boats can now approach the place. Ten years ago, this was a fishing center of considerable note; whitefish and other desirable species became scarce, however, and at times almost entirely disappeared; the fisheries consequently declined.

Point Peninsula.—This promontory forms the larger part of the southern boundary of Chaumont Bay, and is 6 miles in length and 3 in width. It is connected with the main land on the northwest by a narrow strip, only a few yards wide. There are about four hundred people on this promontory, all farmers, who engage in fishing to a small extent, none making a business of it. Six or eight years ago the reverse was true; fishing was in the ascendancy and farming was of comparatively little importance.

Kinds of nets employed.—Pound-nets, which were so extensively used five years ago, have been almost completely replaced by trap-nets, and at the present time there are only seven pound-nets in Chaumont Bay or off the point, and five of these are set for alewives. Gill-nets and fyke-nets are the other forms of apparatus employed.

Species and abundance.—In 1885, the principal fishing was for herring which were taken in gill-nets. In addition to these, bull-heads and pike were the only abundant species, although sturgeon, bass, and eels were not uncommon. Whitefish and trout are very scarce, the latter being particularly so. There was, however, a decided increase of whitefish in 1885 as compared with the previous year, and ample testimony is at hand to show that whitefish are becoming more abundant. More fish two and three years old have been seen than ever before.

Disposition of products.—Nearly four-fifths of the herring were cleaned and packed in salt in half-barrels, about one-third of which were sold at Chaumont where also most of the other fish are landed. A few fish are reserved by the fishermen for their own use.

The trade.—The fishermen get their supplies from Chaumont and pay for them in fish. Two sail-boats that belong at Chaumont collect fish from Stony, Galloo, Grenadier, and Fox Islands. The fish are shipped to New York and other eastern cities, whitefish and trout each representing one-twentieth of the entire amount; the larger part of these were obtained from Canada and many other kinds also come from there. Mr. Dewey has kindly furnished the following figures of the fish trade of Chaumont in 1885:

Pounds of fresh fish purchased from fishermen: Whitefish, 10,000; trout, 12,000; sturgeon, 30,000; bull-heads, 16,000; eels, 10,000; other fish, including pike and pickerel, bass, etc., 180,000.

Number of half-barrels of salt fish bought from fishermen: Herring, 100.

Number of half-barrels of fresh fish salted before shipping: Whitefish, 10.

Average price per pound paid to fishermen for fresh fish: Whitefish, 6 cents; trout, 6 cents; sturgeon, 4½ cents; bull-heads, 3 cents; eels, 3 cents; other fish, 4 cents.

Manufacture of fish oil and guano.—This enterprise was inaugurated at Pillar Point in 1884. Operations were begun in a rather primitive way. A small seine, 198 feet long and 12 feet deep, was the only apparatus at first employed for capturing the alewives, which are used for making oil and fertilizer. The cider-press which was at first employed to express the oil proved wholly insufficient to utilize all the fish landed. The results of the year's work were only 60 gallons of oil and 5 tons of fertilizer. In 1885 great changes and improvements were made. The seine was discarded and five pound-nets were substituted in lieu thereof; apparatus that had been used in the manufacture of menhaden oil and scrap was brought from Maine; and as a result the output of the factory in 1885 was nearly ten times greater than that for the previous year. The methods pursued in 1885 were about as follows: The fish were taken from the nets with a scoop and transported in boats to the factory, where they were transferred to a car and run by steam to the top of

the building; here a trap in the car was opened and four cooking vats received the fish; steam was then allowed to enter and the fish were cooked for twenty minutes; after draining for an hour, they were put in circular perforated curbs holding 5 barrels of fish each, and a pressure of 90 tons was applied by means of a hydraulic press. The oil thus obtained was purified in the usual manner and the scrap was dried and ground, and sold to the farmers for fertilizing purposes. In connection with this industry seven fishermen and three shoresmen were employed in 1885.

Statistics.—The men engaged in the fisheries numbered 64, of whom 21 were professional fishermen, 36 semi-regular fishermen, and 7 shoresmen and preparators. The fishing property consisted of 23 gill-net boats, 2 collecting boats, and 8 other boats; 185 sturgeon gill-nets, 34,550 feet long; 82 whitefish gill-nets, 14,685 feet long; 292 herring gill-nets, 80,365 feet long; 7 pound-nets, 29 trap-nets, 121 fyke-nets; 1 fish-car; and accessory apparatus and shore property. The capital invested in boats amounted to $1,585; in gill-nets, $2,560; in pound-nets, trap-nets, and fyke-nets, $5,120; in wharves, buildings, etc., including working capital, $7,770; giving as the total sum invested in the fisheries, $17,035.

The catch comprised 50,000 pounds of herring, 37,300 pounds of bullheads, 35,000 pounds of pike, 11,100 pounds of sturgeon, 9,730 pounds of bass, 5,950 pounds of eels, 2,200 pounds of whitefish, 400 pounds of trout, and 1,000 pounds of miscellaneous fish. Of the herring 36,220 pounds were salted. To the above should be added about a million alewives from which 500 gallons of oil and 63 tons of fertilizer were made. The total value of the fish was $6,945.

119. THE VICINITY OF CAPE VINCENT, JEFFERSON COUNTY, NEW YORK.

Relative importance of the fisheries.—Cape Vincent is a town of 2,000 people on the St. Lawrence River, 3 miles from the lake. The inhabitants are nearly all farmers, of American birth. Compared with farming, the fisheries are of little importance and engage the attention of only a small number of men. Within the last ten years interest in the fisheries has greatly declined, owing to a scarcity of fish.

Fishing grounds.—The fishing grounds of the fishermen of Cape Vincent are Charity Shoal, and the waters of Grenadier and Fox Islands, no net-fishing being allowed in the river. Charity Shoal is in the lake, 6 miles from the head of the St. Lawrence; it is three-quarters of a mile long and a quarter of a mile wide, and is submerged to the depth of 5 to 7 feet. Whitefish and trout spawn here in considerable numbers. The dimensions of Grenadier Island are $2\frac{1}{2}$ by $1\frac{1}{2}$ miles. Fox Island is irregular in shape, the greatest length being $1\frac{1}{2}$ miles, the greatest width three-quarters of a mile. Off these islands the fishing is done in 20 to 30 feet of water. Six or eight men from Oneida Lake fish near the islands, their boats and nets being shipped by rail to Cape Vincent.

Angling.—The fine facilities for line-fishing in the vicinity of Cape Vincent attract many anglers; and a number of fishermen make a living by transporting visitors to the fishing grounds in boats. Quite a trade in minnows used for bait has sprung up; one case is cited where a dealer sold $500 worth of such bait in a year. The minnows bring $1 per hundred, and a careful estimate shows that about 600,000 were consumed in 1885.

Apparatus employed.—The fishermen use gill-nets, trap-nets, and fyke-nets, or "hoop-nets," as they are locally called. Gill-nets are employed chiefly in the capture of sturgeon, the use of these nets for taking whitefish and trout having been to a great extent discontinued about four years ago, up to which time they were operated very extensively. Trap-nets have in a measure taken the place of the whitefish and trout gill-nets, and have, with a single exception, entirely superseded the pound-nets which were in vogue about five years ago. Trap-nets differ from pound-nets in that they are smaller, are not staked, and are closed at the top. The bottom of the net is held in position by weights, and the top is buoyed with wooden floats. The trap is much cheaper than the pound and possesses a decided advantage in its being readily moved from place to place. The trap is provided with a leader about 500 feet in length, with a 7-inch mesh, and wings 40 feet in length, with a 5-inch mesh, while the body of the trap has a 3-inch mesh. A few sturgeon and all the smaller kinds of fish are taken in these trap-nets. The fyke-nets are similar to those used in other parts of the lake. Bull-heads, bass, pike, and eels are the kinds of fish to the capture of which the fyke-net is adapted. One pound-net and one seine complete the list of apparatus; these were used during a portion of the season on Grenadier Island. The fishermen usually make their own nets, getting twine and other materials from the fish-dealers of Cape Vincent, who take their pay in fish.

Abundance of the different species.—Of the species of fish landed at Cape Vincent sturgeon rank first in importance. They are taken almost exclusively in gill-nets, which are set at all times when there is no ice. Pike are perhaps the most abundant fish, with the possible exception of bull-heads. They are readily sold and some men fish only for them. Bass occur in considerable numbers, and are caught principally by anglers. Whitefish are very common; in fact in 1885 they were in greater abundance than they had been for many years, although their size was somewhat below the average. Trout are fairly common; the quantity actually landed, however, has been greatly reduced since sturgeon fishing was inaugurated, and the same may be said to be true as regards whitefish. About a hundred and fifty shad were taken in 1885, this species having been introduced by the U. S. Fish Commission.

Fish trade of Cape Vincent.—Nearly all the fish landed at Cape Vincent are bought by two dealers, who ship them to New York City. The wharves, buildings, and working capital devoted to this business were

valued at $26,500, including $13,000 invested in Canadian property and $3,500 in cash capital. Twenty men in the capacity of shoresmen and preparators were employed by the dealers.

In 1884 the fish trade of Cape Vincent amounted to 575 tons, of which 175 tons were frozen before shipment. The following year only 470 tons of fish were handled, of which 18 tons were frozen. In the former year about two-thirds of the fish were whitefish and trout, a somewhat higher percentage than in 1885. Canadian fisheries operated by the dealers furnished more than half of the supply. A detailed statement of the fish trade of Cape Vincent in 1885 is given in the following table:

Name of species.	Fresh fish purchased from fishermen.	Average price paid per pound.	Fresh fish salted before shipping.	Fresh fish frozen before shipping.
	Pounds.	*Cents.*	*Half bbls.*	*Pounds.*
Whitefish	310,000	5½		34,000
Trout	170,000	5½		1,800
Sturgeon	60,000	4½		
Herring	15,000	3	100	
Bull-heads	180,000	3½		
Pike and pickerel	80,000	4		
Eels	35,000	3½		
Other fish	20,000	1½		
Total	870,000		100	35,800

Statistics of the fisheries.—Forty-four professional fishermen, 9 semi-professional fishermen, and 2 shoresmen and preparators were employed in this region in 1885. The fishing property comprised 20 gill-net boats, 1 collecting boat, and 16 other boats; 503 sturgeon gill-nets, 85,140 feet in length; 180 whitefish and trout gill-nets, 17,325 feet in length; 1 pound-net, 138 trap-nets, and 53 fyke-nets; 1 seine, 330 feet in length; and wharves, buildings, etc. The capital invested in boats was $2,330; in gill-nets, $2,975; in pound-net, trap-nets, and fyke-nets, $5,620; in miscellaneous apparatus, shore property, and working capital, $27,490, the total value of the fishing outfit and accessories being $38,325.

The fish taken included 130,900 pounds of sturgeon, 104,100 pounds of pike, 73,000 pounds of bull-heads, 27,100 pounds of bass, 20,600 pounds of whitefish, 16,400 pounds of eels, and 12,300 pounds of trout, 400 pounds of which were salted; the total value of the entire catch being $16,850.

INDEX.

2.—REPORT UPON THE DIVISION OF FISHERIES.

By J. W. Collins.

ANALYSIS.

A.—Introduction.

The Division of Fisheries was established at a date so near the close of the fiscal year that little time remained to organize the work, and get it into successful operation, during the period covered by this report. For this reason, comparatively little can be said here concerning what has been accomplished by this branch of the Fish Commission. In the following pages, however, such facts as relate to the organization of the division, and the events that led up to it, have been recorded. Mention has also been made of the work subsequently performed, and the plans for future effort.

In the months preceding the establishment of the Division of Fisheries much work was accomplished and many interesting events transpired which are intimately associated with this division, and may, therefore, be appropriately referred to in this report. Indeed, it is believed that a review of these matters is necessary to insure a clear and comprehensive understanding of the conditions under which the division entered upon its duties, and also to convey an idea of the scope of its efforts in the interest of the commercial fisheries.

It has been the desire of the writer to mention all matters of moment, and to do full justice to all who have been prominently identified therewith. It is possible that he has not fully succeeded, for he was absent from Washington a considerable portion of the year—a year remarkable for occurrences of exceptional importance to the Fish Commission, resulting from the death of Professor Baird, which in a large measure had a tendency to overshadow all minor matters.

The particular work that is considered to be the function of the Division of Fisheries, which has heretofore been carried on by the Commission without special appropriation, and under conditions that hampered its full development, has now been specifically authorized by Congress, and the money appropriated is available for the next fiscal year. It is confidently anticipated that the importance of this inquiry will be recognized in the future, and that the means will not be wanting to prosecute it actively, so that it may become an important agency in developing and improving the fisheries of this country.

B.—Organization of the division of fisheries.

The Division of Fisheries was instituted by the Commissioner, Hon. Marshall McDonald, on May 24, 1888, on which date he announced its establishment, and appointed an assistant to assume charge of the division and the direction of its work.

The organization of a division of the Fish Commission to which may be referred all matters specially pertaining to commercial fishing, including statistics, has been a matter which for some years has received the serious consideration of those who have been prominently identified with the work of the Commission. As early as 1885 a committee, acting under authority of Professor Baird, submitted a scheme of organization of the Commission, which contemplated among other things a division which would be charged with duties and responsibilities similar to those now devolving upon the Division of Fisheries. It was not, however, deemed advisable at that time to accept the plan submitted, though it is only just to say that it met the approval of the Commissioner, and it has served as a basis for the organization of the work that has since been adopted.

The non-adoption of the organization recommended at that time was largely due to the fact that Professor Baird's administration was essentially paternal. During the formative period of the Fish Commission he watched over its work with true parental solicitude. Having thought out the problems he desired to solve, arranged in his own mind the line of investigation to be followed by individuals, and considered the means at his command, present and prospective, he naturally hesitated to relinquish personal control of affairs, and preferred instead to endure the cares and responsibilities which, with the rapid development of the work, weighed heavily upon him in the last years of his life.

It is, however, proper to state that he was in a large measure relieved in the study of the methods and relations of the fisheries, as well as the collection of statistics, by the work performed by Professor Goode and his associates in 1880, and subsequently, in coöperation with the Census Office. This work covered a very wide scope of investigation of this nature, and rendered it unnecessary while it was in progress for the Fish Commission to attempt any similar undertaking on a large scale, though it is true that certain additional investigations were made and a number of interesting independent papers were prepared and published bearing upon the methods and relations, as well as the current status and development of the fisheries.

In 1885, however, when the termination of the Washington treaty and the anticipation of negotiations for a new treaty rendered it necessary to have information concerning the current condition of the fisheries, Professor Baird made an effort to acquire statistics of the vessel fisheries and to obtain certain other data which he deemed were necessary for the information of the Government. The inquiry contemplated then was largely of a statistical nature, and the means were not available for prosecuting the work upon a basis sufficiently large to meet all requirements. But with the assistance expected from the Treasury Department by an arrangement which was made to furnish, through the Customs Division, statistical returns of the vessel fisheries, it was anticipated that much could be accomplished in the direction of obtain-

ing the desired information. A small corps of clerks was detailed to attend to this work, and others were temporarily assigned to field duty, but no special or official organization was established.

In the *Provisional Regulations* issued by Professor Goode during his short term as Commissioner, a "Division of Statistical Inquiry" was designated. The special work and purposes of this division were not defined, and it is not known to the writer whether it was contemplated that this inquiry should take a broader scope than merely the collection of statistical data (as implied by the title), particularly as there was not sufficient time during his administration in which to formulate or definitely establish the line of investigation which was to be prosecuted by that division.

There are many potent reasons why the collection of statistics should be closely associated with the study of the methods and relations of the commercial fisheries. The two are naturally inseparably connected, and, in order that the statistics may be fully understood, and that proper explanations may be made, it is necessary for the Commission to be in possession of full information as to the manner in which the fisheries are prosecuted and the influences which may affect them for good or evil. Besides, without a full knowledge of all matters affecting the fisheries, including statistics, it would be impracticable for the Commission to successfully continue one of its most important functions—one which has heretofore proved of inestimable advantage to these industries—that of suggesting important changes in apparatus, methods, etc., which may prove beneficial to those engaged in fishing enterprises.

Many more equally potent reasons might be urged to show the wisdom of organizing the division upon its present basis. In a subsequent report (made after the work has been well crystallized), I hope to deal with this subject at greater length; here it is seemingly only necessary to allude to the growing importance of the commercial fisheries from an international as well as a national standpoint, and to call attention to the necessity that exists on that account for the Government to constantly have accessible not only detailed statistics, but a mass of information such as may be required at any time to properly demonstrate the conditions that influence the development or well-being of these industries, and which may be essential to a full understanding of statistical statements that otherwise might not easily be comprehended.

The inquiry concerning statistics of the fisheries, etc., that was inaugurated by the Commissioner in 1885 and prosecuted in subsequent years during the lifetime of Professor Baird, was under the immediate charge of Mr. R. Edward Earll. This gentleman was also in charge of the Division of Statistical Inquiry during the administration of Professor Goode as Commissioner, and he retained that position under Colonel McDonald until May 13, 1888, when he resigned.

At that date I was on duty at Gloucester, Massachusetts, and was

making the necessary preparation for an extended trip of reconnaissance of the fisheries of the Pacific coast. Soon after, the Commissioner ordered me to report in Washington, which I did, and my appointment in charge of the Division of Fisheries took place, as has been stated. In the mean time, however, pending my arrival at Washington and subsequent employment, Mr. Hugh M. Smith was assigned (immediately after Mr. Earll's resignation) to the charge of the office of statistics, as acting assistant.

The courtesies which are usually extended in cases of resignation rendered it nominally impracticable for me to take control of the statistical work until near the close of the fiscal year, though, in compliance with the Commissioner's request, I assumed that responsibility at a slightly earlier date.

C.—Plans for conducting the work.

Having been placed in control of the division almost at the end of the fiscal year, and being charged with important duties other than those strictly pertaining to its operations (of which mention is made elsewhere), it is but just to say that there has been scant time to formulate definite plans of work and to effect a proper organization for its conduct before the expiration of the time covered by this report. The difficulty was augmented by the assignment of a considerable portion of the clerical force of the division to other duties.

In view of these facts, and because it has been settled that my duties will compel me to be absent from Washington for several months, a tentative plan of work has been decided upon which seems feasible and adapted to the circumstances in which the division is now placed. This provisional scheme contemplates an inquiry into the methods and relations of the fisheries, and the collection of fishery statistics, by sending experts into the field to supplement the information obtained through other methods that were in operation when the division was organized. Besides this, it has been determined to make special effort to compile reports from material gathered by previous inquiries, and which for various reasons has remained unutilized. In subsequent paragraphs more extended mention is made of these proposed compilations, as well as of other matters directly concerned with the work of the division and its relation to the past.

In contemplating a permanent organization of the work of the division, and the adoption of the best methods for collecting information, I am now strongly in favor of the establishment of a corps of trained field experts, who may be sent to different sections of the country to make a personal canvass of the fisheries. Experience has demonstrated that it is impracticable by other means to secure sufficient knowledge of the many peculiar conditions affecting the fisheries, and the manner of their prosecution, to render it possible to intelligently compile the data ob-

tained and to make such explanations as will lead to a clear understanding by the public of otherwise complex and intricate problems.

It is probable that, when the field force has been well organized, we shall be able to discontinue the collection of statistics through the Treasury Department, and thereby relieve it of an onerous duty it has so generously undertaken and so zealously prosecuted. Unless Congress should authorize the continuance of this work, it seems that the Commission can scarcely continue to request it of the Treasury Department when the organization of the force of this division renders it practicable to secure the desired information through inquiries made by field agents. I am, nevertheless, not unmindful of the fact that many data are secured on Treasury circulars that it may be difficult to obtain by other means, chiefly through the inability of field experts to personally interview those who can supply the knowledge sought for.

For many reasons, it seems eminently desirable that local agencies should be established in the most important fishery sections, and it is hoped that Congress may recognize the importance of this, as bearing upon the welfare and development of the fishing interests of this country.

D.—Consideration of the status of the work, personnel, etc., when the division was organized.

1. *The work, sources of information, etc.*—As has been intimated, the work of the newly organized division naturally includes that which came under the jurisdiction of the Division of Statistical Inquiry, as established by the *Provisional Regulations* of Professor Goode. It, therefore, seems necessary to briefly review the work that had previously been done, and to define its status at the time I assumed control of it, in order that the conditions under which the Division of Fisheries began operations may be clearly understood.

Although, under the direction of Professor Baird, the collection of fishery statistics and the study of certain phases of the fisheries had been carried on by the Commission from early in 1885, no specific appropriation was made by Congress for this work; the Commissioner, acting under authority conferred by Congress, assigned at his discretion such funds as he could devote to it, the amount depending largely upon the character and extent of the inquiries undertaken. The first specific appropriation made by Congress for the collection of fishery statistics by the Commission was passed during the first session of the Fiftieth Congress, and is available for the next fiscal year.

Early in 1885 an arrangement was made by Professor Baird with the Treasury Department for the collection (through the Customs Division) of statistics of certain vessel fisheries, and this work was organized by the preparation and distribution to customs officials of the necessary

blanks. In addition to this the sources from which the Commission derived information at first are as follows:

(*a*) From daily trade reports of the Boston Fish Bureau, which contained information concerning arrivals of fishing vessels at Boston and generally a statement of the amount of fish landed by them.

(*b*) Information of a similar character concerning vessels arriving and landing fish at Gloucester, Massachusetts, was obtained from daily reports received from the American Fish Bureau at that port.*

(*c*) Weekly and monthly reports were forwarded by Capt. S. J. Martin, the agent of the Fish Commission at Gloucester, Massachusetts. These showed the daily arrivals of vessels, the amount of fish landed by each, the locality where the fish were taken, and many other interesting data, including the quantities of fish landed by boats fishing from Gloucester harbor.

(*d*) Considerable information was received through correspondence with the fishermen and fish dealers.

The data thus obtained were available for utilization in the preparation of tables at short notice showing certain phases of the vessel food fisheries, etc. Information secured in this manner did not, however, embrace within its scope the shore fisheries or those prosecuted by vessels for the capture of whales, seals, and walrus.

(*e*) *Newspaper clippings.*—In the consideration of the sources of information mention may properly be made of the many newspaper clippings that were received from different sources containing information relating to the fisheries, fish culture, etc., constituting, when properly classified, a valuable collection for reference.

(*f*) *Special investigations, etc.*—During the summer and fall of 1885 a comprehensive investigation was made of the fisheries of the Great Lakes. The following summer inquiries were made into the condition of the sardine industry of Maine, and certain other fisheries at Eastport, while a study of the spring mackerel fishery was also undertaken, and certain phases of the menhaden industry were investigated. With the exception of a brief inquiry in 1887 into the use of salt clams for bait, their production and exportation to Canada, no other field work was attempted after 1886 until the organization of the Division of Fisheries, the small force being engaged chiefly in routine work in the office; in compiling statistical data for the information of Congress and for the use of the international commission that met in Washington during the winter of 1887–'88 for the purpose of negotiating a new fisheries treaty.

At the time of my appointment in charge of the Division of Fisheries I found that, for various reasons, which are more specifically mentioned elsewhere, little or nothing had been done in elaborating certain data collected in the field investigations. One of my first duties, therefore,

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* This bureau was discontinued in the fall of 1887; consequently no reports were received from this source after that time.

has been to make the necessary arrangements for the utilization of these data and for the preparation of reports for publication, and though only about a month has elapsed since the establishment of the division, such gratifying progress has been made that some of the smaller papers are nearly completed and will soon be ready for publication, while the larger work on the Lake Fisheries is well under way.

2. *Personnel and duties.*—At the date of the organization of the Division of Fisheries the following persons were employed in the office of statistics, or were otherwise connected with its work, their duties being as specified:

Hugh M. Smith: Had general direction of the work; attended to all the correspondence, and was also engaged in the preparation of special reports.

W. A. Wilcox: Engaged in compiling statistics of vessel fisheries from Treasury circulars.

M. M. Snell: In charge of card catalogue and fish bureau reports; assisting in the preparation of special reports.

W. H. Abbott: Employed in miscellaneous compiling, assorting circulars and newspaper clippings; registering circulars, etc.

H. R. Center: Engaged in compiling statistics from Treasury circulars, for States not covered by the compilations of Mr. Wilcox.

S. J. Martin: Employed at Gloucester, Massachusetts, as a local statistical agent, his duty being to make weekly and monthly reports of all vessels arriving and landing fish at that port, the receipts of all fish caught in small boats, and other general information bearing upon the fisheries of that place.

Besides those mentioned above as being specially connected with the work of the office of statistics, Mr. Charles B. Hudson, artist, and Mr. E. C. Bryan, stenographic clerk, were permanently assigned to the division by the Commissioner. At that time Mr. Luther Maddocks was in the field engaged, under the direction of the Commissioner, in collecting statistics of the shad fishery from Florida to the Chesapeake. A little later he was assigned to the Division of Fisheries (while the results of his work were also placed under its control), and he may, therefore, properly be included in the personnel of the division when it was organized.

E.—Routine work.

There is a large amount of work in connection with the compilation of statistics, etc., which may properly be characterized as routine. Under this head may be placed the following:

3. *Work relating to statistical circulars.*—This consists (*a*) in acknowledging to collectors of customs the receipt of circulars containing statistics of the fisheries; (*b*) registering the same; (*c*) examining circulars and making comparisons for detection of errors; (*d*) correcting errors (this sometimes involves considerable correspondence), and (*e*)

making compilations. During the fiscal year the official correspondence of the office aggregated 653 letters, covering 848 pages. Of this 440 letters, covering 530 pages, were written to collectors of customs and other officials of the Treasury Department relating to statistics reported on Treasury circulars.

4. *Miscellaneous correspondence.*—There has been a considerable amount of miscellaneous correspondence relating to the business of the office. This has been chiefly with the Executive Departments, the committees of Congress, and the International Fisheries Commission, and has related principally to matters connected with the fishery relations between the United States and Canada. As will be seen from the foregoing paragraph, 213 letters of this character were written during the year.

5. *Preparing a card catalogue.*—A card catalogue is kept of fishing vessels sailing from the United States upon which is recorded all information of the fishing fleet that is obtained from the bureau reports, letters and records of Fish Commission agents, newspapers, etc. This is alphabetically arranged, according to names, and contains, in addition to names, rig, tonnage, and hailing port, all information obtained regarding each vessel that relates to her movements, etc., including fares of fish landed, where landed, date, etc. Thus a life history of each vessel is recorded, and it is thereby feasible to trace its work and movements, so far as information concerning it has been received.

6. *Classification of newspaper items.*—Items relating to the fisheries which have been clipped from newspapers are received from various sources, but chiefly from established agencies. These are pasted on paper and filed. A rough classification has been attempted, but the system now in vogue is inadequate to the needs of the office, and can be materially improved. I have made an extensive private collection of material of this character, much of which has been systematically classified. This has been placed at the service of the division.

7. *Increase of routine work, etc.*—In considering the routine work of the office it is proper to state that it has increased to such an extent that the force which could be assigned to it without any special provision by Congress has been found inadequate, and it has been necessary to make extra exertion to keep current work from getting behindhand. This inadequacy was greatly increased in the latter part of the year by the assignment of myself and several clerks to duty in connection with the preparation of the Fish Commission exhibit for the Cincinnati Exposition.

F.—STATUS OF UNCOMPLETED REPORTS.

8. *General considerations.*—Allusion has already been made to the fact that, at the date of the organization of this division, reports concerning certain important investigations of special fisheries were either incomplete or had not been begun. The paramount importance of preparing these reports for publication as soon as practicable is so evident

that I believe no doubt can exist concerning it. In the following paragraphs more detailed statements are given, under appropriate headings, of the status of this part of the work. A consideration ot these will convey a knowledge of present conditions and will also show that the effort to prepare these reports or complete those already begun must necessarily restrict the activity of the division in other directions during the next year at least. The matters which seem to deserve special mention are as follows:

9. *Fisheries of the Great Lakes.*—The inquiry concerning the fisheries of the Great Lakes, which was instituted by Professor Baird in 1885, had for its object the obtainment of as full and definite information of those industries as it was practicable to secure. The supposed expansion in products, value, etc., of the lake fisheries, the intimate relations existing between Canadian fishery enterprises and American markets, and the influence of artificial propagation by the national and State Fish Commissions upon the most important lake fisheries were the principal reasons for making the investigation. It should be borne in mind, however, that the fishery clauses of the Washington treaty had just expired, and it was believed that a consideration of the fishery relations between this country and Canada might be somewhat influenced by a full knowledge of existing conditions in the lake region.

The prosecution of this inquiry was delegated to Mr. Earll, who was assisted by six gentlemen, all employés of the Commission. To facilitate the inquiry, the region was divided into sections, and each assistant was given a certain area to canvass. Work was begun in August, 1885, and continued through the months of September, October, and November.

Notwithstanding the fact that the investigation was practically completed that year, the elaboration of the field notes and the compilation of the review has been delayed, and to the present time little has been done. There have been, of course, many causes for delay which were obviously imperative. Chief among these were the press of other matters connected with the routine work of the office; the absence in the field or assignment to other duty of those intrusted with the preparation of such reviews, thus practically leaving no one available for undertaking the responsible duty of elaborating field notes and compiling reports. Preliminary work on a review of the lake fisheries has been begun, under my instructions, and as soon as practicable it will be made ready for printing; it ought to be completed during the coming year.

10. *The sardine industry.*—The report upon the status of this industry in 1886 has been vigorously pushed forward of late; it is now well advanced and will soon be ready for printing. The report includes much interesting information, among which may be especially mentioned complete statistics; a discussion of changes that have occurred in recent years in the methods of capture of fish and their preparation for market;

the influence upon the industry of the abrogation of the fishery clauses of the Washington treaty; the probable effect of the proposed import duties on Canadian fish, especially in regard to the obtainment of raw material, the cost of canned goods, and the importation of European products.

11.—*Notes on certain fishery industries of Eastport, Maine, in* 1886.—These notes contain the latest information concerning (*a*) the winter herring fishery and the frozen herring trade in the vicinity of Eastport; (*b*) the trade in pickled herring; (*c*) the preparation of bloater herring; and (*d*) the smoking of "finnan haddies." They are now well under way and it is expected they will soon be sent to the printer.

12.—*Spring mackerel fishery in* 1886.—One of the special inquiries prosecuted in 1886 had for its object a comprehensive study of the spring mackerel fishery. The principal points upon which information was sought were (*a*) statistics, whereby the relative quantities of mackerel taken in the spring fishery, and on other grounds later in the season of 1886, could be shown; (*b*) the effect of the spring fishery upon the price of mackerel caught and salted later in the season, and (*c*) whether the capture of large quantities of this species in the spring has a tendency to seriously affect its abundance.

The data obtained were valuable and timely. Much information has been supplied to Congress and it has been utilized in connection with the consideration of the probable effect of legislation prohibiting the importation or landing of mackerel caught before the first of June.

This inquiry, like some others relating to different branches of the fisheries, was conducted by Mr. Earll, who, up to the time that he severed his connection with the Commission, was unable to put the notes into shape for publication. Considering the great amount of work of this nature which is pressing for consideration, together with the urgent necessity for prosecuting field investigations, it seems scarcely feasible to do more than to arrange for the early publication of the statistics relating to the spring mackerel fishery, the methods of which have received full consideration in previous reports of the Commission.*

13. *The menhaden fishery.*—During the summer of 1886 Messrs. R. E. Earll, Hugh M. Smith, and M. M. Snell made an investigation of the menhaden fishery. Much information was obtained concerning the extent of the fishery, location of fishing grounds, factory plants, and the effects of the methods of capture now employed in the menhaden fishery. Many of these data have been compiled and tabulated for the use of Congress, which has had under consideration measures for the restriction of the capture of this species. A considerable amount of new and important information was obtained, but it has not yet been practicable to elaborate the descriptive notes.

*See "Materials for a History of the Mackerel Fishery." Report of the U. S. Fish Commission, 1881, pp. 89–531; also report upon the mackerel fishery, Volume I, Section V, Fisheries and Fishery Industries of the United States, 4to, pp. 247–313.

It may properly be mentioned here that several members of the Fish Commission were called upon to testify before the fishery committees of Congress during the present session (first session of the Fiftieth Congress) regarding the effect upon the abundance of menhaden of the present methods of fishing; and also to inform the committees whether the supposed unwarranted destruction of the species by purse-seines had exerted any important influence upon certain food fishes that are popularly supposed to feed chiefly upon menhaden. In recent years the tendency, on the part of many, has been to ascribe any scarcity of bluefish, weakfish, striped bass, and other valued food species to the influence exerted by the menhaden fishermen. It has been thought by some that the capture of large quantities of menhaden drove that species from the New England coast north of Cape Cod, and caused a general decrease in its abundance; also that there was danger of its practical extermination, and a consequent scarcity in our waters of those species which prey upon it.

The testimony furnished by the Commission, which was the result of careful scientific study, showed that many of these popular beliefs were unfounded, and the prediction was ventured that menhaden might at any time reappear in the waters north of Cape Cod in as great abundance as they were formerly found in that region. It is certainly a remarkable verification of that prediction that, after having been absent from the Gulf of Maine for 10 years, the menhaden has this summer returned to its former haunts along the coasts of Maine and Massachusetts where it is now reported as being enormously abundant.

14. *Statistics collected by means of the Treasury circular.*—In preceding chapters attention has been called to the method of collecting statistics of certain vessel fisheries through the coöperation of the Treasury Department. This system of obtaining such data is a new feature in the work of the Fish Commission and justly deserves consideration in this report.

In compliance with the request of the Commissioner, the Secretary of the Treasury issued, on December 16, 1885, a circular (No. 177, Bureau of Navigation) embodying certain questions, answers to which were required from owners, masters, or agents of fishing vessels whenever they made application at the customs houses for a renewal of a vessel's papers, or when such were surrendered. It was expected that in this manner very accurate detailed statistics could be obtained with comparatively little trouble and practically without expenditure.

Many difficulties were met with at the start, however, that were not anticipated, and it took considerable time and much patient labor and perseverance to bring the system into working order. At first it was not infrequently the case that the circular would not be properly filled out, and in some cases no attention would be given to it. This, perhaps, might have been expected to some extent, at least, where officials were inexperienced in this kind of work. Such delinquencies were

noted, however, and on several occasions the attention of the Secretary of the Treasury has been called to the matter, and he has been furnished with a list of those who have failed to comply with instructions—a course which has generally proved very efficacious in securing the necessary action. As a result, this method is much improved at present; it may, perhaps, fairly be claimed that it is on a practical working basis, though much yet remains to be done to reach the maximum of desired accomplishment in this direction.

In some cases objection has been made to answering certain necessary questions contained in the circular. For that reason steps were taken to secure the enactment of a law making it illegal to refuse such information as may be asked for by the Government. A bill of this character passed the Senate, but failed in the House of Representatives only because there was no opportunity for its consideration before the close of the session. No steps have since been taken to secure its passage, though it is obvious that a measure of this kind would aid materially in the work, and would make its expansion practicable without additional cost to the Government. If this system of collecting fishery statistics is to be continued (a matter concerning which there might be a difference of opinion as to its wisdom or expediency) it ought unquestionably to be legalized by Congress, since otherwise the Secretary of the Treasury may at any time decide to discontinue a work that is not authorized by law.

The extent of this work is much beyond what might be expected by those unfamiliar with it. To fully understand and appreciate this, it is seemingly only necessary to state that in the calendar year of 1886 there were received in the office 3,445 circulars; in 1887 the number had increased to 5,636, and the present outlook indicates the receipt of a still larger quantity this year.

The information thus obtained is carefully considered, compared with other data to verify its accuracy, and then tabulated. In cases where there is reason to doubt the accuracy of the returns on the face of the circular, communication is had with the collector of the port whence the information came in order to verify or correct the statements.

In a number of instances the information on these circulars has been tabulated for the use of Congress and the Executive Departments. These statistical statements have generally had special reference to the fishery relations between the United States and Canada, and have usually been compiled with the object of showing certain phases of the fisheries of New England and the Middle Atlantic States.

The tables prepared to date may appropriately be classed with uncompleted reports. It is proposed to expand them so as to bring the subjects they deal with up to date, so far as that is practicable. Some new features will be added, including explanatory notes, and it is hoped they will soon be ready for publication. It may also be added that many of the same data will be used, in conjunction with other informa-

tion, for compiling complete returns of the vessel fisheries of the country. In the next chapter is given a list of the statements or statistical compilations, papers, maps, etc., that have been furnished to the different branches of the Government during the year, and, considering the small force available for the work, it is believed the showing will be adjudged very creditable.

G.—MISCELLANEOUS REPORTS.

During the year a variety of reports, statistical and descriptive, have been prepared, chiefly for the executive and legislative branches of the Government. This matter has been incidentally referred to in preceding chapters; here it is proposed to present it more in detail, in order that the amount of work of this character performed by the Commission may be more fully understood.

15. *List of statistical statements, descriptive notes, etc., furnished to Congress and the Executive Departments.*—The following is a list of the most important statistical tables, descriptive notes or reports, etc., which have been furnished to Congress and the Executive Departments during the year:

(*a*) Number of American fishing vessels entering British North American ports, including those of Newfoundland, in 1885, and the amount of money expended by them in said ports for bait, ice, supplies, etc.

(*b*) The halibut fleet of the United States in 1880, classified according to the fishing grounds.

(*c*) The mackerel fleet of the United States in 1880, classified according to fishing grounds.

(*d*) The codfish fleet of the United States for 1880, classified according to fishing grounds.

(*e*) Total number of men employed on New England fishing vessels in 1886, and the nationality of same.

(*f*) Quantity of fresh and salt mackerel landed by the New England fleet in 1886, and the localities in which the fish were taken.

(*g*) Names, tonnage, and hailing ports of all American vessels entering the Gulf of St. Lawrence in 1887, with a summary of mackerel caught by them in said waters.

(*h*) Quantity of salt mackerel packed in Portland during 1887, with percentage caught in the Gulf of St. Lawrence.

(*i*) Thirty-six original statements of owners and masters of vessels whose fishing operations in 1886 were interfered with by the action of the Canadian government. This was additional to the list transmitted to Congress by the Secretary of State on February 5, 1887.

(*j*) Statement of the amount of salt clam bait shipped from the United States to the British Provinces in 1886 and 1887.

(*k*) Table showing the number of New England vessels engaged in the cod fisheries that frequented grounds east of longitude 65° W., during the year 1886; together with the locality where fishing and the kind of apparatus used.

(*l*) Table showing the average catch per man and per vessel for 5 years, 1879, 1884, 1885, 1886, and 1887, of Gloucester vessels employed in the off-shore cod and in the fresh halibut fisheries.

(*m*) Table showing in detail, by States, the relative importance of the menhaden fisheries during the years 1880 and 1886, respectively.

(*n*) Table showing the dates of first appearance of mackerel along the different portions of the coast in 1887, as indicated by their capture in pounds and weirs located between Virginia and Nova Scotia. Also date of first importation of mackerel in 1887, and date of entrance of fish into Gulf of St. Lawrence.

(*o*) Table showing by customs districts the number and nationality of men employed in the vessel fisheries of Massachusetts in 1886.

(*p*) Statistical summary of the American mackerel fishery in the Gulf of St. Lawrence in the year 1887.

(*q*) Table showing the extent and value of the vessel fisheries of the customs districts of Philadelphia, comprising the ports of Philadelphia, Pennsylvania, and Camden, New Jersey, during the year 1887.

(*r*) Table showing the value of fishery products imported into the United States from Canada and Newfoundland during the year ending June 30, 1887.

(*s*) Table showing the value of the products of the Canadian fisheries in the year 1886, not including those of Newfoundland.

(*t*) Table showing the value of fishery products imported into the United States from Canada and Newfoundland, during the year ending Juue 30, 1886.

(*u*) Statement of the value of the different New England fisheries in 1886.

(*v*) Summary of American vessels fishing for cod in the Gulf of St. Lawrence in the years 1885, 1886, and 1887.

16. *Report entitled "Some reasons why the fishermen of Nova Scotia prefer to use salt clams (Mya arenaria) for bait in the bank hand-line cod fisheries."*—These notes I prepared for the use of the Commissioners who negotiated the fishery treaty between the United States and Great Britain in the winter of 1887–'8. A rather full presentation of the matter was made, including statistics to show the results obtained by using salt clams for bait.

17. *Notes relating to improvements in dories and other fishing-boats, in the matter of carrying food, water, etc., for the better protection of the lives of fishermen engaged in the deep-sea fisheries.*—On February 28, 1888, a bill was introduced in the House of Representatives by Hon. Wm. C. P. Breckinridge, of Kentucky, "for the better protection of life to the fishermen of the United States engaged in the deep-sea fisheries, etc., and for other purposes."

This bill was referred to the Commissioner for consideration, and at his request I prepared a report on the subject, containing twenty-seven type-written pages, and also several drawings illustrative of the text.

The question of alleviating or preventing the suffering and fatalities that so frequently result from fishermen going astray in boats without food or water, or other adequate provision for their safety and welfare, has attracted much public attention of late, and demands have been frequent in the public press for the enactment of a law to benefit the fishermen in this particular.

For this reason, and because of the difficulty of enacting the proper legislation without a full understanding of the points involved, the matter was deemed of sufficient importance to call for an extended review.

18. *Maps showing the distribution of certain bait and food species.*—In the latter part of 1887 I was directed by the Commissioner to superintend the preparation of four large colored maps of the region from

Cape Hatteras to Labrador, showing the distribution of certain bait and food species, for the use of the International Fisheries Commission then in session at Washington. I was assisted in the work by Mr. Gregor Noetzel, who was charged with the drafting work. The following is a list of the maps:

(*a*) Map showing the geographical distribution of the halibut; the principal fishing grounds; the regions of former abundance and present scarcity; important fishing ports, and other facts relating to the halibut fishery of the east coast of North America.

(*b*) Map showing the distribution of the cod family; the principal fishing grounds and localities frequented by cod fishermen of the United States; the important fishing ports and baiting stations, and other facts relating to the cod fishery of the east coast of North America.

(*c*) Map showing the geographical distribution of mackerel; the regions of the greatest abundance and localities frequented by mackerel fishermen of the United States; inshore fishing grounds in British provincial waters of possible importance to the mackerel fishermen of the United States; the important fishing ports, and other facts relating to the mackerel fishery of the east coast of North America.

(*d*) Map showing the geographical distribution of the principal species of fish and mollusks used as bait for cod and halibut, as well as for food and other purposes, the important baiting stations, and other facts relating to the bait supply of the east coast of North America.

19. *Notes on the use of squid for food.*—Early in the year my attention was accidentally called to a remarkable innovation in the ultilization, on the Atlantic coast, of squid (*Loligo peali*) for food. Desiring to obtain full information on the subject, I communicated with Mr. E. G. Blackford, a prominent dealer in the Fulton fish market, New York City, and Mr. Atkins Hughes, North Truro, Massachusetts, who owns several traps and weirs in that vicinity. The result of this correspondence was printed in the Bulletin for this year. The occurrence is of such interest, however, that it is but proper that mention of it should be made here.

H.—NOTICE OF FIELD WORK; PROPOSED INVESTIGATIONS, ETC.

Under this head it is proposed to consider such phases of the work as relate to field inquiries prosecuted during the year; the plans for undertaking new investigations; the preparation of blanks or schedules, and such other matters as seem to be naturally connected therewith.

20. *Field work.*—Very little field work has been done during the past year. The many important events which occurred during the year were of a nature to practically preclude the possibility of undertaking many new investigations. The fatal illness of Professor Baird, that culminated in the sad event which deprived the Commission of its loved and honored chief and founder, had a most depressing effect, while the conditions resulting from his death and the necessity that existed for giving special attention to other vitally important matters placed the statistical inquiry under specially unfavorable influences.

21. *Bait investigation.*—No field work was attempted until the appointment of Professor Goode as Commissioner. Soon after, Mr. W. A. Wilcox was sent to Maine to make a special inquiry concerning the use of clams (*Mya arenaria*) for bait by cod fishing vessels, and the extent of the exportation of salted clam bait to the British North American Provinces. The information thus collected (which was supplementary to that secured at the same time by correspondence with merchants and customs officials) was required for the use of the International Fisheries Commission that was then in session at Washington. This work was satisfactorily accomplished and the results obtained were promptly transmitted to the Fisheries Commission.

22. *Inquiry into the shad fishery.*—Soon after the appointment of the present Commissioner, Mr. Luther Maddocks was directed to make an inquiry into the condition of the shad fisheries of the South Atlantic States, from Florida to and including Chesapeake Bay. This investigation was ordered primarily for the purpose of noting the effect of artificial propagation upon the abundance of the shad and the capture of that species in the region covered by the inquiry. It therefore naturally included the collection of statistical data, the location of fixed apparatus of capture, and the obtainment of other information incidentally or directly connected with the shad fishery.

The field work was completed in April, and Mr. Maddocks has been employed since that time, until the close of the fiscal year, in elaborating his notes.

23. *Proposed investigation of the Pacific coast fisheries.*—The fisheries of the Pacific coast are of great importance, and, being chiefly prosecuted along the shore or in bays and rivers, come largely under the classification of "shore fishery." For this reason detailed comprehensive information can not be obtained concerning them except by special investigation, since the circulars received through the coöperation of the Treasury Department do not include the shore fishery, nor do they apply to the now valuable industries of whaling and sealing which are important features in the Pacific fisheries.

But, although it was thus manifestly desirable that the status of the fisheries of that region should be well understood, it has not been feasible since the census of 1880 to send Fish Commission agents there to make an inquiry into their extent and value. The Commissioner, Colonel McDonald, was, however, strongly impressed with the importance of making a comprehensive study of the Pacific fisheries, and early in his administration he decided to undertake it. His plans contemplated a preliminary reconnoissance of the coast fishing stations before detailing agents to make the investigation, and he proposed to send me to the Pacific States for that purpose, as has been stated elsewhere. Unexpected events and unanticipated exigencies of the service combined to temporarily frustrate the proposed inquiry, but it is hoped that it may soon be practicable to undertake it.

24. *Instructions for fishery expert on the Albatross.*—In the autumn of 1887 the steamer *Albatross* was ordered to the Pacific Ocean for the purpose of studying the fishing grounds of that region, attempting the discovery of new fishing areas, and carrying on other investigations for the purpose of developing the fishery resources of the region.

In organizing the staff of naturalists and experts to accompany the ship, after her arrival at San Francisco, it was thought necessary to include some one familiar with the methods pursued in the Atlantic fisheries, who could be intrusted with making inquiries relating to commercial fishing, and whose experience would be of service in conducting fishing operations, preparing apparatus, etc. Accordingly, Mr. A. B. Alexander, who had previously served on board the schooner *Grampus*, was assigned to this duty on my recommendation.

The instructions relating to the work to be performed by Mr. Alexander on the *Albatross* were comprehensive and detailed. It is believed they will prove amply sufficient for the purpose, and that he will be able to make many important observations concerning the methods and relations of the fishing industries on the Pacific coast.

25. *New forms of statistical blanks.*—At the time I assumed control of the work of the division the schedules or blank forms used for collecting statistics of the shore and vessel fisheries were the same as those prepared for the census work of 1880. These did not include many details that are important, and in various other respects they were inadequate and unadapted to the work of fishery investigation as now conducted by the Commission. For the above reasons, one of the first duties to which my attention was directed was the preparation of new forms which seemingly include all that is requisite for securing complete statistics of the extent and value of the fisheries. For convenience two forms were adopted (instead of the single blank as formerly used), one for the shore fisheries and another for the vessel fisheries, each of which has distinctive features that render it inexpedient to have one schedule apply to both.

Instructions for the guidance of field agents were also prepared, and it is believed that even those who have had comparatively little experience in collecting fishery statistics can, by using these blanks and conforming to the instructions, meet with success in obtaining the requisite information.

These schedules, when printed, have been bound in books containing one hundred blanks each. A set of instructions adapted to the blanks is bound in each book. The size of the blanks is such as is well adapted to field work, since they are convenient for carrying in the pocket.

I.—Notice of special matters affecting the fisheries.

During the year just ended many things have occurred of more than ordinary importance to the fisheries. While some of these matters have been more or less closely associated with the work of the Commission,

others are of a more general character, and are mentioned here only because of the great influence which they may exert in the future upon the welfare or development of certain fisheries. The following notes are simply brief references to the most noticeable events, the object being rather to call attention to them than to discuss them in an exhaustive manner, since it would scarcely be practicable to do the latter in a report of this kind.

26. *Use of antiseptic preservatives.*—The use of antiseptics as a substitute for common salt for preserving fishery products, particularly those intended for food purposes, has received marked attention in Europe in recent years and is beginning to attract the notice of those in this country who are interested in the fisheries. In Europe the use of "preservatives" has practically passed the experimental stage, speaking from a commercial standpoint. One result is that an immense trade has grown up between Norway and English markets, the Norwegians sending to England large quantities of so-called fresh herring, mackerel, codfish, etc., that have been "preserved" with antiseptics. The success attained in Europe by the use of this new agent for preserving fish is well known in the United States, and numerous experiments have been made here to test its usefulness. But while partial success has been reached in some cases, it is, nevertheless, true that the matter is still in the experimental stage.

For several years past Dr. J. H. Kidder, formerly chemist of the Commission, and late Assistant and Acting Commissioner, has experimented with some of the "processes" used in Europe. To facilitate these experiments Professor Baird purchased and imported complete apparatus for preserving fish by the Roosen process. This was tested. Those interested in other processes were informed that the Commission would be glad to see the results they could attain. Consequently, in addition to what was done under Dr. Kidder's direction, various packages of fish put up in Europe were received and opened by the Commission, after the lapse of a certain time, the effect on the contents being carefully noted. The results so far obtained have not been entirely satisfactory, and the utility of these "processes" for American markets has not been fully established. What seems to be eminently, if not imperatively, needed in this country as a fish preservative, is something that will prevent deterioration long enough to permit of transportation to markets hundreds of miles distant from the centers of production, and with a margin of time sufficient to effect sales after the goods reach their destination. Nothing else will fully meet the requirements of a domain of such extensive proportions as the United States; though there can be no reason to doubt that advantages will accrue to fish packers by using antiseptics for the preservation of products intended for markets comparatively near and for early consumption. It is anticipated that much benefit may be secured by the use of antiseptics in moderate quantity on pickle-cured dried codfish, to pre-

vent the reddening in summer that results from the growth of a plant (*Clathrocystis*), much to the detriment of the trade. In this case, however, the material will not be employed to preserve the fish, which are already heavily salted, but the object is simply to prevent the growth of the noxious plant.

It is also possible that antiseptics may be used to advantage on bait, particularly on clam bait, in conjunction with common salt; though it is probable that an extended series of experiments will be required to fully determine the effect of this treatment upon the flavor of the bait. The mere preservation of bait from deterioration is a secondary matter as compared with the retention of that flavor which is attractive to fish, and which is often present to a considerable degree in fish or mollusks that are heavily salted. However, if these can be kept in a comparatively fresh condition, with the original flavor correspondingly unaffected, much benefit might accrue to those engaged in the hand-line bank cod-fishery, in which salt bait is chiefly used.

Dr. Kidder has recorded the results obtained from the experiments conducted by him, and I understand that, as soon as his time will permit, notes containing a full discussion of the experiments made and results secured will be prepared and printed. It is anticipated that these notes will contain much that will be instructive and of interest to those concerned in the preparation of fishery products.

I have had the opportunity of observing the results obtained in several practical tests of two of the best known "processes." These are known to the trade as the Roosen and Purcell methods. In the following notes the result of the experiments, as they came under my observation, are briefly stated.

27. *The Roosen process.*—I have had only two opportunities for examining food products preserved by the Roosen method, as follows:

On April 24, 1888, I was present at the warehouse of Hon. E. G. Blackford, at New York City, when two packages of fish were opened which had been put up in accordance with the Roosen formula. There were present also Hon. E. G. Blackford, fish commissioner of the State of New York, Dr. J. H. Kidder, Mr. C. G. Kidder, Mr. C. H. S. Schultz, and another gentleman.

The first package opened contained a lot of codfish that had been eviscerated and placed in the solution on February 24, precisely 2 months previously. The metallic cask in which the fish were packed was about half full of cod, but was well filled with the preserving fluid. The solution was clear on top of the cask, nearly odorless, and tasted like salt water.

The skin of the cod looked bright and fresh, but the eyes were sunken and red; the flesh, too, where it had been cut in the process of evisceration had a reddish tinge and a slight odor. Some of the fish were cooked and eaten, and proved very palatable.

The second package was a cask containing herring, which were

packed at Gottenburg, Sweden, during the preceding February. The contents of this package were found to be very offensive and considerably decayed. Some of the specimens were moderately hard, but wholly unfit for food or bait.

28. *The Pursell process.*—On May 28 a keg of about 8 gallons capacity, filled with split haddock (finnan haddies), which had been preserved by the Pursell process about 3 or 4 months previously, was opened at Central Station of the U. S. Fish Commission in the presence of Dr. J. H. Kidder, Mr. W. P. Seal, and myself. The top layer of fish was covered with a white mold, but had no offensive smell whatever; the remainder were bright, sweet, and firm in flesh, and apparently in good condition. Specimens were given several persons for trial, who reported that the fish tasted strongly of the acid—so much so as to render them unpalatable.

It is very possible that the result might have been materially different had this package been opened in about a month or 6 weeks after it was put up. I believe that the contents might have still retained much of their original flavor and value for food purposes if they had been subjected to a shorter test.

29. *Experiment with bait.*—On May 11, 1888, I had the opportunity to be present, at Gloucester, Massachusetts, when an experiment was made by Mr. C. H. S. Schultz to preserve bait for sea fishing by the Roosen process. The object was to determine if bait preserved by that method could be utilized by American fishermen with good practical results. This is a matter in which the U. S. Fish Commission has taken more than ordinary interest, since success in this direction would be a matter of the greatest importance to our sea fishery. For this reason I gave Mr. Schultz what assistance I could and noted the chief points of interest in connection with the experiment. The following extracts from a memorandum, which I sent to the Commissioner on May 26, contains information relating to the obtainment and packing of the bait on this occasion:

> Sea herring and squid could not be obtained, as it was not the season for them to approach the coast, and on May 10 I went with him [Mr. Schultz] from Gloucester to Essex to secure some alewives, which was the only bait fish then obtainable. Although the town statutes prohibit the capture of more than fifty fish by any individual, the authorities were very kind and considerate when learning from me the purpose for which the fish were required, and offered to supply what Mr. Schultz needed for his experiments without charge. This they did on the following day, and Mr. Story, with whom I am personally acquainted, very generously volunteered to haul them to Gloucester without any expense to Mr. Schultz. The fish were put into the preservative on May 11, and I understand that they are to be practically tested some time during the summer or autumn.

I am informed that after being kept about a month the bait was put on board of a cod fishing vessel going on a short trip to the banks. When opened the alewives were found to be in excellent condition—sweet and sound. Nevertheless the fishermen say they were totally unattractive to cod, and therefore wholly worthless for bait.

While this may foreshadow future results, I think it would be unwise to accept it as entirely conclusive. It is therefore to be hoped that these experiments will be continued in the future, and with a variety of material commonly used for bait.

30. *Investigations relating to the mackerel.*—Although not directly connected with the work of this division, the investigations undertaken by the schooner *Grampus* during the year, relating particularly to the occurrence or abundance of the mackerel in certain localities, are so intimately associated with the commercial aspects of the fishery for this species that it seems entirely appropriate to call attention to them here.

For more than 50 years reports have been circulated at intervals of the occurrence of mackerel in great abundance on the northeast coast of Newfoundland and along the shores of Labrador, particularly in the Strait of Belle Isle and vicinity. These reports have generally emanated from vessels trading in those regions, but, as a rule, they have gained circulation too late in the season for the mackerel fishermen to profit by them if true, while there has been associated with apparent reliability more or less of indefiniteness and uncertainty which has left the whole matter in an undetermined condition. For this reason the procurement of precise information respecting the truth of these reports has been a matter of especial interest to American fishermen, particularly in the past year, when the exceptional scarcity of the mackerel in its usual haunts has caused much anxiety and restlessness in the minds of those in pursuit of this species, and a consequent increased desire to learn from reliable sources all that may affect the welfare of the industry in which they are engaged.

In view of these conditions, the *Grampus* was ordered to make a cruise, in the summer of 1887, to the Gulf of St. Lawrence, the east and northeast coasts of Newfoundland, and along the coast of southern Labrador, including the Strait of Belle Isle. The principal object of this voyage was to determine the truth or falsity of the reports of the occurrence of mackerel in those localities. I was in charge of the investigation. The cruise began on July 2, on which date we sailed from Gloucester, Massachusetts, and it ended on September 1, when we arrived at Wood's Holl.

Careful inquiry developed the fact that mackerel have not occurred on the northeast coast of Newfoundland for considerably over a decade, with the exception of scattering specimens taken occasionally in gillnets. It was learned that the species has occasionally been moderately plentiful for a brief period in the Straits of Belle Isle and vicinity, as late as 1885. But this fact loses its significance when it is known that such appearances of the mackerel in that region are very uncertain and that when found there it is invariably in a poor and emaciated condition and scarcely fit for food.

The information obtained was promptly disseminated among the mackerel fishermen, who were met by the *Grampus* on her return voy-

age, and later in fishing towns, and it may reasonably be assumed that its result has been to prevent the undertaking or continuance of unprofitable trips, and the loss of much valuable time by fishing vessels.

During the past 3 months the *Grampus* has been continuously and actively engaged in a research having for its principal object the careful observation of the mackerel during its spring migrations, both as relates to its movements and abundance. This investigation is of exceptional importance this year for two reasons:

First, mackerel were very scarce during the previous season, as has already been intimated, and therefore much importance attaches to having early information which may indicate their probable abundance during the present summer.

Second, this is the first year of the so-called "close-time mackerel law," which prohibits the catching of mackerel (except those "caught with hook and line from boats, and landed in said boats, or in traps and weirs connected with the shore,") between March 1 and June 1 of each year while the law continues in force; namely, for 5 years.

In view of the fact, therefore, that vessels engaging this year in the mackerel fishery have practically been debarred from making the usual observations in spring, the cruise of the *Grampus* was looked forward to as possibly being the means of supplying the fishermen with much useful information which would be of immediate practical value. Under ordinary circumstances such result would undoubtedly have been accomplished. But, strange as it may seem, the *Grampus* failed to meet with large schools of mackerel during her cruise which has just ended; only a few small-sized fish have been seen. While it is to be regretted that such is the outcome of her trip, since it would be more gratifying to record conditions indicative of prosperity to the mackerel fishermen, it will, nevertheless, be apparent that the result conveys useful and important information to those most interested, for it is thus placed almost beyond question that mackerel will be even less numerous this year than they were last season—a probability which it may be very important for the fishing interest to know at the beginning of the season.

31. *The importation of salted bonito as mackerel.*—The exceptional scarcity of the common mackerel (*Scomber scombrus*) on the fishing grounds of the western Atlantic during the past year resulted in the supply of that species being much below the demand and a consequent increase in the price. The supply from ordinary sources being inadequate, dealers have sought to obtain from other countries material for filling their orders, and in one case at least an attempt has been made to place on the American market an allied species imported from Europe as a substitute for mackerel. It is highly probable that a confusion of common names may have led to the importation alluded to, since it is by no means impossible that the foreign shipper may not have known that the fish he sent to the United States differed materially if any from our common mackerel. And it is also supposable that he may have been

equally ignorant of the fact that, with the exception of the bull's-eye mackerel (*Scomber colias*), which closely resembles the common species, no fish has been found that satisfactorily fills the place of *Scomber scombrus* in the markets of the United States.

Early in April my attention was called to an importation of what was called "Black Sea mackerel," 89 barrels of which had been salted and shipped to this country from Turkey as an experiment. Wishing to obtain fuller information concerning the so-called mackerel, I corresponded with the firm in Boston, Massachusetts, to whom the fish were consigned, and was courteously furnished specimens and all the facts relating to the importation.

The fish proved to be the common bonito (*Sarda sarda*). They were about the size of extra large No. 1 mackerel of the common species; perhaps a few were slightly larger; they were split down the back; had evidently been soaked before being salted, were "rimmed," and with the exception that the flesh was very dark, their resemblance to mackerel was sufficiently close to pass for the latter among people unfamiliar with its special characteristics.

Several persons to whom specimens were given for trial, and who are thoroughly competent to pass judgment regarding the edible qualities of the bonito when prepared in this manner, reported them to be a fair substitute for mackerel, though the flesh was rather oily and coarse, and less delicate in flavor than that of the latter.

These so-called mackerel were said to have been caught in the Bosporus, and, so far as I am informed, this is the only instance where an attempt has been made to supply our markets with such a substitute for the common mackerel from foreign countries.

It is pertinent here to remark that the bonito occurs off our own coast in considerable numbers, and is frequently specially abundant on the California coast. If a sufficient demand could be obtained for it as a substitute for mackerel there seems to be no doubt but what the demand could be supplied to a considerable extent by our own fishermen.

What is, however, of still greater importance to the fishing interests of this country at the present time is the fact that the demand for mackerel caused by the exceptional scarcity of the common species off the Atlantic coast may, to a considerable extent, at least, be supplied from the coast of California, where the chub or bull's-eye mackerel (*Scomber colias*) occurs in great abundance. This species finds a ready sale in our markets; those caught in the Atlantic are nearly the equal of the common mackerel, and for this reason it is probable that an important mackerel fishery may be established on the southern coast of California if the attempt is made by those having sufficient skill and enterprise.

J.—PARTICIPATION IN THE CENTENNIAL EXPOSITION OF THE OHIO VALLEY AND CENTRAL STATES.

The participation of the Commission in the exposition to be held at Cincinnati during the early part of the coming fiscal year deserves brief mention here, for it has exerted a marked influence upon the work of the Division of Fisheries since its establishment. This has been due to the connection of myself and others of the personnel of the division with the Fish Commission Exhibit, which, from the time of my appointment in charge of it, has occupied most of the time and attention of those who have been detailed to this work. This would, perhaps, have been less noticeable if my appointment in charge of the exhibit had not been so nearly simultaneous with the organization of the Division of Fisheries.

On May 28, 1888, a bill which was introduced early in the month became a law and provided for the participation by the "several Executive Departments of the Government and the Bureau of Agriculture and the Smithsonian Institution, including the National Museum and Commission of Fish and Fisheries," in the Exposition of the Ohio Valley and Central States, to be held at Cincinnati, Ohio.

The provisions of the bill directed that the different Departments and bureaus of the Government, as above mentioned, should "prepare and make suitable exhibit at the said Centennial Exposition," and that the head of each Department and bureau should appoint a person, from among the officers or employés thereof, to act as representative to have responsible charge of and to supervise the preparation and conduct of such exhibit.

In accordance with the provisions of the aforesaid act the Commissioner, on June 2, 1888, designated me as the representative of the U. S. Fish Commission to have the responsibility of the preparation, installation, and conduct of the exhibit, in addition to the ordinary duties as chief of the Division of Fisheries.

Although this action was taken as soon as practicable after the passage of the act making it necessary, the appointment was, nevertheless, made only about a month prior to the opening of the Exposition, which is to take place on July 4. The time thus available for the preparation of the exhibit of the Commission has therefore been entirely insufficient. This inadequacy has been more noticeable, too, for various important reasons.

First. It was necessary at the outset, before the scope and characacter of the exhibit could be definitely decided upon, that I should visit the Exposition grounds and buildings at Cincinnati to obtain information regarding available space, probable location of our exhibit, facilities for obtaining water for aquaria, etc. This caused a delay of several days.

Second. Several gentlemen whose services were specially needed in

connection with the preparation, installation, and conduct of the exhibit were absent from Washington on other duty (one of them nearly across the Continent and another at sea), and it was not practicable to get the personnel all assigned until after June 20.

Third. It has been necessary to prepare specially for this occasion much of the material embraced in the exhibit. Several new features have been introduced that were not included in previous exhibits made by the Fish Commission.

Because of the foregoing reasons I have had to give my personal attention to details in the preparation and packing of the material, a duty that has necessitated night and day work.

Notwithstanding the many difficulties attending the assembling of the material constituting the exhibit, and the very short time available for getting it ready, it is gratifying to be able to record the fact that at the close of the fiscal year the work is rapidly nearing completion, and it is anticipated that the shipments will be made in three or four days, about which time the personnel assigned to duty in connection with the installation and conduct of the exhibit will leave Washington for Cincinnati, with the exception of one or two, who will have to remain to look after certain details that require additional attention.

32. *Detail of persons from the Division of Fisheries.*—In the report upon the exhibit made by the Commission at Cincinnati that will be prepared in due time and to which reference is made, full details will be given of the personnel. Here it is intended only to consider those whose connection with the affair affected the work of the Division of Fisheries.

Three of the force of the division beside myself have been detailed to assist in the preparation of the exhibit. These are Messrs. E. C. Bryan, W. H. Abbott, and H. R. Center. It is scarcely necessary to remark that the work of the division has suffered during the past month by the assignment of so many persons from its limited number. Nevertheless, much was accomplished by the division, as has been stated in previous chapters of this report, though it is beyond question that the work would now have been much farther advanced had it been practicable to keep the entire force engaged upon it.

33. *Arrangement for conducting statistical work, etc.*—As has been shown, the demands upon my time and attention in connection with the preparation of the exhibit, and the fact that it will be necessary to devote myself almost exclusively to affairs at the Exposition for some months to come, renders it impracticable for me to retain more than a general direction of the office work of my division, leaving the details in the hands of another. Therefore, on June 3, Mr. Hugh M. Smith, who has long been associated with the office, was placed in charge of the statistical work, including compilation of reports, to act under my direction. This arrangement has been very satisfactory, since it has thus been possible for me to give more exclusive consideration to duties connected with the Exposition.

THE GRAMPUS.

K.—My association with the schooner *Grampus* has been so intimate in the past, and her work being to a large extent connected with a study of the deep-sea fisheries, it seems appropriate that mention should be made of her here.

I held command of the vessel from the time she went into commission, on June 5, 1886, until the organization of the Division of Fisheries, though most of the time I have been on special detached duty, in Washington or elsewhere.

My official connection with the schooner ceased on the day of my appointment in charge of the division, and on the following day (May 25, 1888) the first mate, Capt. D. E. Collins, who had been acting master for the most of the time since the vessel was built, was promoted to full command; Mr. E. E. Hahn, the second mate was made first mate, and Mr. Frank Conley was appointed second mate.

In preceding pages allusion has been made to the work accomplished by the *Grampus* during the year, having a special bearing on the commercial phases of the fisheries. Reference is made to a report upon her operations, pp. 491–598 of this volume, for more detailed information, and also to pages 437–490 for a report which I have prepared upon her construction, etc.

3.—REPORT OF DISTRIBUTION OF FISH AND EGGS BY THE U. S. FISH COMMISSION FROM JULY 1, 1887, TO JUNE 30, 1888.

The aggregate number of fish and eggs distributed by the U. S. Fish Commission, as collated from the reports of stations, in the period comprised between July 1, 1887, and June 30, 1888, was 238,986,117, an increase of more than twenty-eight millions over the distribution during the eighteen months preceding this period. The distribution by species is shown in the following summary, from which it will be seen that the species receiving most attention, named in the order of their importance, are the shad, the whitefish, the cod, and the salmon.

Summary of distribution for the year ending June 30, 1888.

Species.	No. of eggs.	No. of fish.	Total.
Atlantic salmon (*Salmo salar*)	924,000	459,200	1,383,000
Landlocked salmon (*Salmo salar* subsp. *sebago*)	345,000	45,400	390,400
Brook trout (*Salvelinus fontinalis*)	215,000	31,286	246,286
Rainbow trout (*Salmo irideus*)	341,000	155,856	496,856
Brown trout (*Salmo fario*)	5,000	55,010	60,010
Loch Leven trout (*Salmo levenensis*)	50,000	....	50,000
Lake trout (*Salvelinus namaycush*)	547,000	105,760	652,760
Sälbling (*Salvelinus alpinus*)	7,417	....	7,417
Whitefish (*Coregonus clupeiformis*)	32,412,000	19,300,000	51,712,000
Shad (*Clupea sapidissima*)	39,095,000	134,631,000	173,726,000
Codfish (*Gadus morrhua*)	189,432	9,470,640	9,660,072
Lobster (*Homarus americanus*)	196,000	614	196,614
Flounders (*Paralichthys dentatus*)	....	220,000	220,000
Carp (*Cyprinus carpio*)	....	175,410	175,410
Goldfish (*Carassius auratus*)	....	5,437	5,437
Red-eye perch (*Ambloplites rupestris*)	....	3,105	3,105
Black bass (*Micropterus dolomieu*)	....	550	550
Total	74,326,849	164,659,268	238,986,117

Summary of production and distribution of shad and shad eggs, season of 1888.

	Fort Washington Station.	Central Station.	Battery Station.	Steamer Fish Hawk.	Total.
Eggs collected	81, 177, 000		105, 315, 000	48, 607, 000	235, 099, 000
Eggs received by transfer		63, 137, 000			
Total	81, 177, 000	63, 137, 000	105, 315, 000	48, 607, 000	235, 099, 000
Fish deposited in local waters	1, 475, 000		16, 709, 000	14, 840, 000	33, 024, 000
Fish shipped to other waters		39, 664, 000	45, 932, 000	16, 011, 000	101, 607, 000
Eggs transferred to other hatcheries	63, 137, 000				
Eggs shipped to State commissions			3, 000, 000	6, 197, 000	9, 197, 000
Eggs delivered to car No. 2		5, 665, 000	5, 402, 000	2, 139, 000	13, 206, 000
Eggs delivered to car No. 3		7, 686, 000	9, 006, 000		16, 692, 000
Fish lost in hatching			366, 000		366, 000
Eggs lost in shrinkage en route from Fort Washington to Central Station	7, 112, 000				7, 112, 000
Eggs lost in transit from Fort Washington		4, 886, 000			4, 886, 000
Eggs lost in incubation	9, 453, 000	5, 236, 000	24, 900, 000	9, 420, 000	49, 009, 000
Total	81, 177, 000	63, 137, 000	105, 315, 000	48, 607, 000	235, 099, 000
Gross output	1, 475, 000	53, 015, 000	80, 049, 000	39, 187, 000	173, 726, 000

Distribution for the year from the various stations, arranged by species.

WHITEFISH (*Coregonus clupeiformis*).

	Eggs.	Fry.
From Northville Station:		
Forwarded to State commissions to be hatched and deposited in public waters	25, 000, 000	
Forwarded to other United States stations	5, 000, 000	
From Alpena Station:		
Deposited in Lake Huron		15, 000, 000
Deposited in Lake Michigan		1, 000, 000
Deposited in Long Lake		2, 000, 000
From Cold Spring Harbor:		
From eggs received from Northville there were hatched and deposited in Long Island lakes		800, 000
From Central Station:		
From eggs received from Northville there were hatched and delivered to car No. 2 for deposit in Lake Ontario		500, 000
Also for hatching in transit and deposit in same lake	2, 412, 000	
Total	32, 412, 000	19, 300, 000

ATLANTIC SALMON (*Salmo salar*).

From Bucksport Station:		
Forwarded to Cold Spring Harbor Station	500, 000	
Forwarded to the commissioners of Maine, New Hampshire, Vermont, Massachusetts, and Rhode Island	424, 000	
From Cold Spring Harbor Station:		
From eggs received from Bucksport there were hatched and deposited in Hudson River and tributaries of Long Island Sound		459, 200
Total	924, 000	459, 200

Distribution for the year from the various stations, etc.—Continued.

LANDLOCKED SALMON (*Salmo salar* subsp. *sebago*).

	Eggs.	Fry.
From Grand Lake Stream Station:		
Forwarded to State commissions	205,000	....
Transferred to other United States stations	80,000	....
Forwarded to foreign countries (in exchange)	60,000	....
From Wytheville Station:		
From eggs received from Grand Lake Stream there were hatched and deposited in public waters	....	11,400
From Cold Spring Harbor Station:		
From eggs received from Grand Lake Stream there were hatched and deposited in the public waters of New York and New Jersey	....	34,000
Total	345,000	45,400

RAINBOW TROUT (*Salmo irideus*).

From Baird Station:		
Hatched and planted in McCloud River and tributaries	....	* 85,000
Forwarded to applicants and eastern United States stations	218,000	....
Forwarded to foreign countries (in exchange)	33,000	....
From Wytheville Station:		
Transferred to Central Station	....	† 5,200
Forwarded to applicants	....	† 1,535
Hatched and planted in public waters	....	† 12,035
Forwarded to State commissions	35,000	....
Forwarded to foreign countries (in exchange)	45,000	....
From Northville Station:		
Forwarded to applicants	10,000	‡ 390
Hatched and planted in public waters	....	† 8,198
From Central Station:		
From eggs received from Baird Station there were hatched and planted in public waters in Pennsylvania	....	‡ 20,000
From Cold Spring Harbor Station:		
From eggs received from Baird Station there were hatched and forwarded to applicants	....	§ 23,500
Total	341,000	155,856

* Of this number 2,000 were breeding fish and 5,000 yearlings. ‡ Two years old. § Fry. † Yearlings.

LAKE TROUT (*Salvelinus namaycush*).

From Northville Station:		
Forwarded to State commissions and applicants	372,000	....
Forwarded to United States stations	130,000	....
Deposited in Long Lake, Michigan	....	*560
Forwarded to National Fish Cultural Association, London, England	45,000	....
From Cold Spring Harbor Station:		
From eggs received from Nashville Station there were hatched and deposited in public waters	....	† 85,200
From Central Station:		
From eggs received from Northville Station there were hatched and transferred to Wytheville Station	....	† 20,000
Total	547,000	105,760

* Two years old. † Fry.

Distribution for the year from the various stations, etc.—Continued.

BROOK TROUT (*Salvelinus fontinalis*).

	Eggs.	Fry.
From Wytheville Station:		
Forwarded to applicants		* 1,010
Deposited in public waters		* 7,225
Transferred to Central Station, Washington, D. C		* 3,006
From Northville Station:		
Forwarded to applicants	40,000	*45
Transferred to Central Station, Washington, D. C	40,000	
Forwarded to State commissions ‡	135,000	
Forwarded to National Fish Cultural Association, London	10,000	
From Central Station:		
From eggs received from Northville there were hatched and transferred to Wytheville Station		§ 20,000
Total	225,000	31,286

* Yearlings. † Two years old. ‡ Iowa 50,000, Minnesota 60,000, Michigan 25,000. § Fry.

BROWN TROUT (*Salmo fario*).

From Cold Spring Harbor Station:		
Produced from eggs received from Germany this season and distributed to applicants		*14,000
From eggs taken from brood fish raised at the station and distributed to applicants		*40,000
From Northville Station:		
From eggs taken from brood fish raised at the station and forwarded to State commissions	5,000	†500
Deposited in public waters		†500
Transferred to Central Station for aquaria exhibit		‡10
Total	5,000	55,010

*Fry. † Yearlings. ‡ Two years old.

LOCH LEVEN TROUT (*Salmo levenensis*).

From Northville Station:	Eggs.
Forwarded to State commissions	50,000
Michigan	15,000
Minnesota	10,000
New Hampshire	10,000
Wisconsin	15,000
Total	50,000

SÄLBLING (*Salvelinus alpinus.*)

Forwarded from Cold Spring Harbor to applicants in New York, New Hampshire, and Michigan	7,417

CARP (*Cyrinus carpio*).

Summary of carp distributed to private applicants from October 8, 1887, to January 31, 1888, arranged by States.

Date.		State or Territory.	Point of distribution.	No. of counties.	No. of applicants.	No. of fish.
1887.						
Dec.	8	Alabama	Birmingham	31	68	1,380
	5	Arizona	El Paso, Tex	8	43	2,990
Nov.	28	Arkansas	St. Louis, Mo	37	115	5,430
Dec.	5	California	Albuquerque, N. Mex	5	5	100
Nov.	6	Connecticut	Boston, Mass	7	29	596
Oct.	12	Dakota	Fargo	37	70	2,660
Nov.	1	Delaware	Washington, D.C., and New York.	2	4	2,580
Oct.	14	District of Columbia	Washington, D. C	1	3	60
Nov.	22	Florida	Jacksonville	16	39	1,380
	17	Georgia	Atlanta	61	132	2,720
Oct.	22	Idaho	Boisé City, Idaho	8	41	820
Nov.	15	Illinois	Chicago	51	105	14,800
	12	Indiana	Indianapolis	63	136	6,950
	28	Indian Territory	St. Louis, Mo	4	15	580
	27	Iowa	Des Moines	67	177	6,430
Oct.	8	Kansas	Kansas City, Mo	69	250	5,100
Dec.	6	Kentucky	Lexington	34	74	2,030
	12	Louisiana	Jackson, Miss	19	44	1,720
Nov.	6	Maine	Boston, Mass	7	8	160
Oct.	12	Maryland	Washington, D. C	11	35	740
Nov.	6	Massachusetts	Boston	9	16	370
	2	Michigan	Chicago, Ill	32	53	1,060
	21	Minnesota	St. Paul	18	62	7,240
Dec.	12	Mississippi	Jackson	44	147	3,100
Nov.	28	Missouri	Indianapolis, Ind	16	20	500
Oct.	15	Montana	Helena	11	40	920
	13	Nebraska	Kansas City, Mo	30	53	1,140
	28	Nevada	Salt Lake City	2	4	80
Nov.	6	New Hampshire	Boston	1	1	20
Nov. and Dec.		New Jersey	New York City	8	16	340
Dec.	6	New Mexico	El Paso, Tex	10	31	700
Nov. and Dec.		New York	New York City	42	96	4,300
Oct.	12	North Carolina	Raleigh	63	240	5,070
Nov.	11	Ohio	Columbus	53	129	4,160
Oct.	26	Oregon	Portland	15	39	710
	14	Pennsylvania	Washington, D. C	55	194	9,430
Nov.	6	Rhode Island	Boston, Mass	1	1	20
	14	South Carolina	Columbia	25	91	1,930
Dec.	7	Tennessee	Chattanooga	37	124	3,602
Nov.	30	Texas	Dallas	79	293	6,170
Oct.	27	Utah	Salt Lake	29	656	14,320
Nov.	6	Vermont	Boston, Mass	7	18	620
	12	Virginia	District of Columbia and Wytheville.	63	232	2,855
Oct.	18	Washington	Tacoma and Portland	20	63	2,240
	12	West Virginia	Washington, D. C	20	32	1,640
	31	Wisconsin	St. Paul, Minn	26	39	780
Nov.	4	Wyoming	Cheyenne	5	7	300
Dec.	14	Mexico	City of Mexico		1	5,000
		Total		1,259	4,09	136,913

Summary of carp distribution to private applicants, etc.—Continued.

SUMMARY.

States supplied	38	Counties supplied	1,259
Territories supplied	10	Applicants supplied	4,09
Foreign countries supplied	1	Total number of fish	136,913

Number of carp planted in public waters of the United States from October 9, 1887, to January, 1888.

Date.	State.	Place of deposit.	Waters stocked.	No. of fish.
1887.				
Nov. 23	Florida	Live Oak	Suwannee River	400
24	...do	Tallahassee	Oclockneo River	300
16	Georgia	Near Resaca	Chattahoochee River	1,800
16	...do	...do	Etowah River	1,000
16	...do	...do	Oostanaula River	1,000
18	...do	West Point	Chattahoochee River	500
18	...do	Madison	Yellow River	500
18	...do	...do	Oconee River	500
18	...do	Augusta	Savannah River	2,200
19	...do	Jesup	Oconee River	1,000
19	...do	...do	Ogeechee River	1,500
19	...do	Macon	Ocmulgee River	1,000
19	...do	Jesup	Flint River	500
19	...do	Blackshear	Satella River	500
19	...do	Jesup	Altamaha River	800
24	...do	Chattahoochee	Chattahoochee River	200
14	Illinois	Springfield	Lake Vance	1,000
15	...do	Kankakee	Kankakee River	5,000
16	...do	Centralia	Crooked Creek	250
16	...do	...do	Clear River	250
16	...do	...do	Little Wabash River	250
16	...do	...do	Big Muddy River	250
16	...do	...do	Okaw River	250
16	...do	Decatur	Sangamon River	1,000
17	...do	Galesburgh	Railroad reservoir	750
17	...do	Dixon	Rock River	1,000
17	...do	Mendota	Lake Mendota	1,000
17	...do	Aurora	Fox River	2,000
17	...do	Naperville	Des Page River	500
17	...do	Rockford	Rock River	500
Oct. 14	Kansas	Kansas City	Kansas River	2,585
9	Maryland	Pierce's Mills	Rock Creek	1,000
Dec. 7	Michigan	East Saginaw	Mud Lake	500
Oct. 10	North Carolina	Raleigh	Crab Tree Creek	300
Nov. 10	Ohio	McConnellsville	Muskingum River	1,000
Oct. 26	Pennsylvania	Minersville	Lizard Creek	500
27	...do	Easton	Bushkill Creek	500
Dec. 12	Tennessee	Near Rives	Obion River	1,000
12	...do	Trenton	North Fork Deer River	1,000
12	...do	Humboldt	...do	862
1	Texas	Fort Worth	Ponds of Texas Pacific Railroad	250
1	...do	Baird	...do	200
1	...do	Big Spring	...do	150
Sept. 21	Virginia	Staunton	Christian Creek	450
Nov. 16	...do	Buckland	Broad Run	500
	Total			38,497

GOLDFISH (*Carassius auratus*).

Number of goldfish distributed by the U. S. Fish Commission during the season of 1887 *and* 1888.

State.	No. of applications.	No. of fish.	State.	No. of applications.	No. of fish.
Alabama	16	85	Mississippi	3	31
Arizona	1	6	Montana	1	4
Connecticut	3	16	New Hampshire	1	3
Dakota	4	56	New Jersey	4	24
Delaware	4	44	New York	8	66
District of Columbia	484	2, 904	North Carolina	17	127
Florida	9	55	Ohio	24	162
Georgia	10	66	Oregon	3	13
Idaho	1	6	Pennsylvania	27	190
Illinois	5	140	South Carolina	4	30
Indiana	18	90	Tennessee	1	4
Iowa	3	212	Texas	7	42
Kansas	2	60	Utah	5	126
Kentucky	1	6	Virginia	28	†435
Louisiana	5	30	West Virginia	2	12
Maryland	29	190	Washington	1	6
Massachusetts	7	40	Wyoming	1	4
Michigan	2	10	Total	648	5, 437
Minnesota	3	120			
Missouri	4	*22			

* 10 of these were Golden Ides, special.

† 300 of these sent to the Wytheville hatchery for distribution.

RED-EYE PERCH (*Ambloplites rupestris*).

	Fish.
From Wytheville Station:	
Forwarded to applicants	610
Deposited in public waters	1, 000
Transferred to Central Station for distribution to applicants	1, 495
Total	3, 105

BLACK BASS (*Micropterus dolomieu*).

	1 year old.
From Wytheville Station:	
Forwarded to applicants	300
Deposited in public waters	200
Transferred to Central Station	50
Total	550

CODFISH (*Gadus morrhua*).

	Eggs.	Fry.
From Wood's Holl Station:		
Deposited off the coast of Massachusetts	....	8, 843, 600
From Gloucester Station:		
Deposited off the coast of Massachusetts	....	627, 040
Transferred to Wood's Holl Station	189, 432	....
Total	189, 432	9, 470, 640

FLOUNDER (*Pseudopleuronectes americanus*).

	Fry.
From Wood's Holl Station:	
Deposited off the coast of Massachusetts	220,000

LOBSTER (*Homarus americanus*).

	Eggs.	Breeders.
From Wood's Holl Station:		
Transferred to car No. 3 for deposit in the Pacific Ocean off the coast of California	196,000	614
Total	196,000	614

92,000 eggs and 282 breeders were lost in transit; the remainder were successfully deposited in the Pacific Ocean near San Francisco and Monterey, California.

4.—REPORT ON THE WORK OF THE U. S. FISH COMMISSION STEAMER ALBATROSS FROM JANUARY 1, 1887, TO JUNE 30, 1888.

BY LIEUT. COMMANDER Z. L. TANNER, U. S. NAVY, COMMANDING.

AWARDING OF CONTRACT FOR NEW BOILERS.

The *Albatross* was lying at the navy-yard, Washington, D. C., at the close of my report of 1886, awaiting the awarding of the contract for the construction of new boilers, an appropriation for that purpose having been made by act of Congress dated August 4, 1886. The old boilers were not entirely worn out, but the contemplated trip of the steamer to the Pacific coast of the United States made new ones a necessity. The drawings and specifications having been prepared, advertisements were published in the daily press inviting proposals, and on January 10, 1887, the bid of the Columbian Iron Works and Dry Dock Company, of Baltimore, was accepted, the company agreeing to remove the old boilers, construct new ones from designs of Passed Assistant Engineer G. W. Baird, U. S. Navy, alter the deck-house, extend the sky-light, etc., for the sum of $13,439, the work to be completed and the ship ready for sea in one hundred and twenty working days from the delivery of the contract, January 27, 1887.

The expenditure of the appropriation for new boilers was placed under my charge by the following order:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 5, 1887.

SIR: You are hereby placed in charge of the expenditure of the appropriation for the new boilers and refitting of the *Albatross*, and will see the contractors and arrange with them as to commencing their work. Before anything is done, however, they must execute a contract and designate their bondsmen, and the Attorney-General will be called upon to ascertain the ability of the bondsmen to discharge their obligations.

Respectfully,

SPENCER F. BAIRD,
Commissioner.

Capt. Z. L. TANNER,
Commanding Steamer Albatross.

The contractors were informed of the acceptance of their bid, and of my having been charged with the execution of the contract by the following letter:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., January 7, 1887.

SIRS: I write to inform you that your bid for the construction and putting in place, etc., of the new boilers of the steamer *Albatross* has been accepted, and that Lieut.-Commander Z. L. Tanner, commanding steamer *Albatross*, has been charged with the execution of the contracts. The expenditures under the contract will be made under his direction and payments made on his certification of the accounts as provided for by the contract.

Passed Assistant Engineer G. W. Baird, U. S. Navy, has been requested to act as the superintending engineer representing the U. S. Fish Commission, as referred to in the specifications and contract.

Very truly yours,

SPENCER F. BAIRD,
Commissioner.

COLUMBIAN IRON WORKS AND DRY DOCK COMPANY,
Baltimore, Md.

Passed Assistant Engineer G. W. Baird, U. S. Navy, chief engineer of the *Albatross*, was superintending engineer, and later, when the contractors were ready to commence work, Mr. W. Bennett was appointed assistant inspector, and was in the shop during working hours, having supervision over material and workmanship, with instructions to see that the provisions of the contract were strictly complied with, Mr. Baird visiting the works as often as practicable.

EXPERIMENTS RELATIVE TO THE IGNITION OF GUNPOWDER, COAL GAS, ETC., BY A FRACTURED ELECTRIC LAMP.

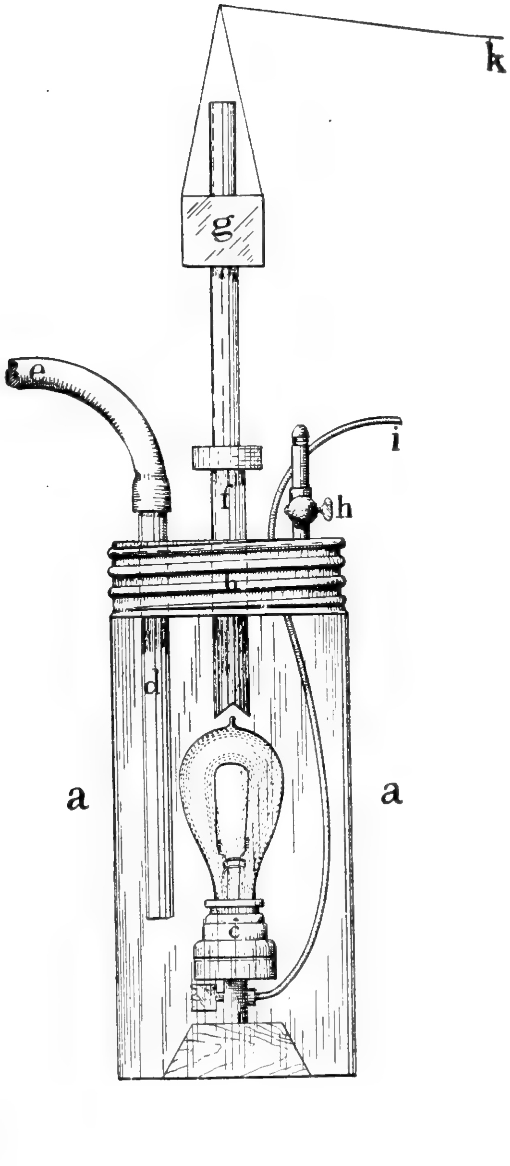
On March 10 experiments were made at the request of the Commissioner of Fish and Fisheries, to determine the results of the fracture of an incandescent electric lamp in contact with gunpowder. The result of these experiments was described in a letter to Professor Baird, of which the following is a copy:

NAVY-YARD, WASHINGTON, D. C., *March* 12, 1887.

DEAR SIR: Your letter of the 7th instant, inclosing a copy of a communication from the Bureau of Navigation, dated March 4, requesting certain experiments to be made with the incandescent electric lamp, etc., was duly received, and, in accordance with your request, I have made the following experiments, viz, to determine the result of the fracture of an incandescent electric lamp in contact with gunpowder:

(1) A 10-candle B lamp was half buried in sand and covered with a mixture of sporting powder and cannon-powder. The lamp was then broken. The powder exploded.

(2) The experiment was repeated, cannon-powder only being used. The powder exploded when the lamp was broken.



APPARATUS FOR DETERMINING THE RESULT OF THE FRACTURE OF AN INCANDESCENT ELECTRIC LAMP IN A COAL-BUNKER CONTAINING COAL-GAS. (See page 3.)

To determine the result of the fracture of an incandescent lamp in a coal bunker where there is coal gas:

(1) A 2-quart butter-jar, *a* (Plate I) was fitted with an air-tight wooden cover, *b*, through which the gas-tube, *d*, electric cable, *i*, and gas-burner, *h*, were passed, all having air-tight joints. The firing bolt, *f*, also passed through the cover, but moved freely, the joint being made air-tight by a ring of putty pressed gently around the rod. A 10-candle B lamp, *c*, was placed in the jar and the cover screwed on. Gas was introduced from a city lamp through the hose, *e*, and tube, *d*, and was lighted at *h*, giving a full flame. The electric lamp was lighted and allowed to burn several minutes, then fractured by releasing the weight, *g*, which, striking the collar on *f*, drove the bolt down and shattered the lamp. The gas did not ignite, but the flame was extinguished.

(2) The experiment was repeated, except that the base of the lamp and bottom of the jar were covered with gunpowder. The lamp was shattered a second time, without igniting gas or gunpowder. The flame was extinguished.

(3) The experiment was repeated, except that immediately preceding the fracture of the lamp the gas was turned off at *h*, leaving the jar air-tight and charged with a full pressure of gas. Neither powder nor gas ignited.

(4) Placed a lighted candle in the jar and turned on the gas, which ignited immediately.

(5) Placed a lighted bunker lamp (lard oil) in an upturned barrel, upper head out, led the hose to bottom of barrel and turned on the gas, which escaped about five minutes, but gas did not ignite.

(6) Placed the barrel on its bilge and introduced the bunker lamp and gas as before. Gas ignited in forty seconds.

There being a vacuum in the incandescent lamp its fracture would cause a strong indraught to fill the void. The burner, *h*, being closed, excluding air, the gas would rush in until the full pressure was attained.

During the first two experiments with gas the burner was left open and lighted:

(1) To show that the jar contained a full supply of gas.

(2) To admit a quantity of air when the fracture of the lamp occurred, in order to increase the inflammability of the gas. The fact of the burner having been extinguished at each trial demonstrates the introduction of air by the indraught before mentioned.

Conclusions:

(1) The fracture of an incandescent electric lamp will explode gunpowder when it is brought in contact with the carbon of the lamp. The latter is consumed so rapidly after its contact with the air that there are no burning fragments scattered about.

(2) The fracture of an incandescent electric lamp will not ignite illuminating gas.

(3) The flame of a candle or bunker lamp (lard oil) will ignite illuminating gas when confined, or partially confined.

Very respectfully,

Z. L. TANNER,
Lieut.-Commander, U. S. Navy, Commanding.

Prof. S. F. BAIRD.

DREDGING OUTFIT SUPPLIED TO THE U. S. S. THETIS.

We remained at the navy-yard until April 5, when we proceeded to Hampton Roads, under the following orders:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 2, 1887.

SIR: It is proposed to supply the steamer *Thetis*, now under orders for the Pacific Ocean and Bering Sea, with such apparatus as may be most conveniently available for making investigations respecting the fisheries of the northwest coast and the general natural history of the country in accordance with the offer of Lieutenant Emory, commanding that vessel. As her departure is imminent it will be impossible to get up in time a special outfit; and you will, therefore, supply such portions of the fishery equipment of the *Albatross* as can be spared for the purpose, and make, without delay, a requisition to replace them.

You will proceed with the *Albatross* to Chesapeake Bay, or wherever the *Thetis* may happen to be at the time, and make a transfer of the articles in question, together with such additional equipment as may be put on board by Mr. Lee or Mr. Rathbun.

If the necessary arrangements can be made, it is desirable that you give Lieutenant Emory and the officers of the *Thetis* an opportunity of witnessing the methods of making collections and observations on the subject in question. On reaching the *Thetis*, therefore, you will invite them to accompany you on a trip of such length as may be most convenient for all parties.

I learn that the officers of the *Thetis* will not be ready for any trip with you before Thursday next; and you will therefore leave the navy-yard, Washington, in time to meet the *Thetis* in Hampton Roads on that day.

Respectfully,

SPENCER F. BAIRD,
Commissioner.

Lieut.-Commander Z. L. TANNER,
Commanding Steamer Albatross.

We anchored off Fortress Monroe at 1.35 p. m., April 6. The U. S. S. *Thetis* arrived on the morning of the 8th, anchoring near this vessel, and at 9.30 Lieutenant Emory with several of his officers came on board for the purpose of witnessing the practical working of our dredging apparatus, for which purpose we got under way and made several hauls of the trawl, coming to anchor again at 11.30. The following articles were transferred to the *Thetis*:

Three hundred fathoms $3\frac{3}{4}$-inch Italian hemp dredge rope, two 11-foot beam-trawl frames, one 8-foot beam-trawl frame, two 11-foot trawl nets, two 8-foot trawl nets, twelve trawl weights, three large and two small dredges, one 16-gallon tank, two 8-gallon tanks, twelve 2-quart collecting jars, eighteen 1-quart collecting jars, twenty assorted bottles, seventy-five homeopathic vials, 30 gallons of alcohol, 25 yards of cheese cloth, one tow-net, two pairs forceps, one package of labels, one record book, two dip-nets, two sieves, six sorting dishes, one "Construction and Equipment of *Albatross*," quarto volume.

CONSTRUCTION OF NEW BOILERS AND OTHER REPAIRS TO THE STEAMER.

At 1.50 p. m. we got under way and stood up Chesapeake Bay, en route for Washington. We passed the night in Cornfield Harbor and, getting under way at daylight on the morning of the 9th, arrived at Washington at 3.30 p. m. We remained at the yard until 9.55 a. m., May 2, when we left for Baltimore, arriving and making fast to the dock of the Columbian Iron Works and Dry Dock Company at 1.25 p. m. of the 3d.

We found the contractors much behind in their work, having, in the first place, been delayed in getting material that would stand the test required by the specifications. They also misapprehended the class of work required, and were compelled to do by hand what a first-class establishment would do with machinery. In order to forward the work as much as possible the pipes, etc., were disconnected from the old boilers by the engineer's department on board and other preparations made for removing them. Owing to the failure of an appropriation the Commissioner found himself unable to carry on shad-hatching at Havre de Grace as extensively as he considered desirable, and to assist him in this work we sent, on May 10, a detail of twenty-one men to that place in charge of a commissioned officer. They returned to the ship June 18, after the hatching season was closed, and proper acknowledgment was made for the work done by them during the season. Surgeon J. M. Flint, U. S. Navy, was detached on the same date and ordered for duty under the Commissioner of Fish and Fisheries. The contract time for the completion of the new boilers also expired on that day.

What with labor troubles, and with the difficulty of getting material, the job was but half completed. The new donkey boiler was taken aboard about August 1. One of the new boilers was taken on board August 4 and the other on the 11th. We went into dry-dock August 19, to scrape and paint the ship's bottom. She was docked last in Norfolk July 2, 1886, and although she had been in the water thirteen months the bottom was not badly fouled. There was, however, considerable rust wherever the dredge-rope and sounding wire had come in contact with the bottom. On August 20 we received intelligence of the death of Prof. Spencer F. Baird, U. S. Commissioner of Fish and Fisheries, this sad event having taken place at Wood's Holl, Mass., on

the afternoon of the previous day. We hauled out of dock August 23 and coaled ship during the 26th and 27th, taking on board 165 tons of anthracite coal. Passed Assistant Surgeon James E. Gardner, U. S. Navy, reported for duty on the latter date.

The vessel received a thorough overhauling while at Baltimore, the labor being mostly performed by our own crew. The iron hull was scaled and painted inside and out, rigging overhauled and renewed where necessary. The seine-boat, which was not suitable for use on ship-board, was exchanged for a new ten-oared cutter, and a new suit of sails and poop awning were procured. The cabin and ward-room were partially refitted, and a large supply of trawl and dredge frames, sounding wire, and shot were obtained. We also received 4,000 fathoms of new dredge-rope, and later a number of deep-sea thermometers and a large supply of trawl-nets, webbing, and fishing apparatus, etc., for our contemplated cruise to the Pacific. In the engineer's department may be mentioned the following: New boilers, a donkey boiler, new coal-bunkers, new electric engine and dynamo, new ventilating fan and engine, many new pipe connections, general overhauling of the main engines, relining of the main shafts, etc., all of which will be described in the report of the chief engineer.

The work dragged along slowly, notwithstanding our own efforts and the efforts of the contractors to complete it, and it was not until September 14 that the ship was in condition to go to sea. At 7 the following morning we cast off from the wharf of the Columbian Iron Works and Dry-Dock Company and proceeded down the bay for the purpose of testing the boilers, machinery, and other apparatus.

INVESTIGATIONS BETWEEN CHESAPEAKE BAY AND WOOD'S HOLL.

We passed the capes of the Chesapeake at 5 a. m., September 16, with clear weather and a fresh breeze from ENE., which caused a moderate sea. At 2.40 p. m. we cast the trawl in 958 fathoms, brown ooze (latitude 36° 52′ N., longitude 74° 23′ W.). It was landed on deck at 6.10, having failed to reach the bottom; a number of specimens were, however, obtained from intermediate depths. Four hauls of the trawl were made on the 17th, between latitude 37° 34′ 30″ N. and longitude 73° 58′ W., and latitude 37° 46′ N. and longitude 73° 56′ W. in from 1,011 to 811 fathoms, bottom green mud. Among the specimens obtained were many crustaceans, cup-corals, pennatulas, shrimp, shells, and a variety of deep-sea fish. The large surface-net was used as occasion offered during the day. Four hauls were made on the 18th, between latitude 38° 31′ N., longitude 72° 53′ W., and latitude 38° 46′ N., longitude 73° 05′ 45″ W., in from 102 to 1,155 fathoms, green mud and sand. Among the specimens were twelve pole flounders, large numbers of *Macrurus*, and other deep-sea fish; starfish, sponges, coral, sea anemones, etc. The surface-net was used as on the previous day. Three hauls were made on the 19th, between latitude 39° 27′ N., longi-

NOTE.—All bearings are true unless otherwise stated.

tude 71° 15′ W., and latitude 39° 42′ N., longitude 71° 17′ W., in from 705 to 1,276 fathoms, blue mud. Many specimens were taken, among them a variety of deep-sea fish, squid, cephalopods, brittle stars, holothurians, shells, *Geryon quinquedens*, and large numbers of skates' eggs. The surface-net was towed during each haul. At 6.15 p. m. we started for Wood's Holl, arriving and making fast at the Fish Commission wharf at 9.50 a. m., September 20.

The engineer's department was employed in making such necessary additions and re adjustments of machinery as were found necessary during the progress of our trial trip. The opportunity was taken to break out store-rooms, etc., and make final preparations for the cruise. Lieut. W. S. Hogg, U. S. Navy, was detached October 15 and ordered to the U. S. S. *Marion*.

PREPARATIONS FOR THE VOYAGE TO SAN FRANCISCO.

At 6 a. m., October 19, we left Wood's Holl for Washington, calling at Newport for the purpose of availing ourselves of the compass station, but the weather being unfavorable, and the facilities for swinging ship not particularly good, we proceeded on our course, arriving at the navy-yard, Washington, D. C., at 11.45 a. m., October 22. Passed Assistant Engineer C. R. Roelker, U. S. Navy, reported for duty on the 23d, relieving Passed Assistant Engineer G. W. Baird, who was detached on the 24th of October and ordered to special duty at the Navy Department. Mr. Baird's service with the U. S. Fish Commission extends over a period of five years and seven months, first on special duty connected with the construction of the *Albatross* and subsequently as her chief engineer. I avail myself of this opportunity to express my appreciation of Mr. Baird's untiring zeal in the performance of his duties and his great mechanical ability, which was always at the service of the Commission. He designed many of our most useful implements on board this vessel, and contributed in no small degree to her success. His advice and assistance were always freely given on matters pertaining to other branches of the work of the Commission, and it is indebted to him for much valuable aid.

Lieut. B. O. Scott, U. S. Navy, was detached on the 31st and placed on waiting orders. Assistant Paymaster C. S. Williams, U. S. Navy, reported for duty on November 5.

We left Washington on the morning of November 10 for the navy-yard at Norfolk, Va., where we arrived at 8.30 on the following morning and went into dry-dock on the afternoon of the same day, to clean and paint the ship's bottom. On the 18th we hauled out and moored alongside the coal-wharf.

Ensigns W. B. Fletcher and Marbury Johnston, U. S. Navy, reported for duty on the 16th, and Ensign W. S. Benson and Paymaster C. D. Mansfield were detached on the 18th. Ensigns E. W. Eberle and C. M. McCormick reported for duty on the 19th. Ensign Fletcher was detached on the same day.

We coaled ship during the 18th and 19th, taking 187½ tons of anthracite on board.

The scientific staff reported on the 19th, bringing with them such articles as were not put on board ship before her departure from Washington. Everything was ready for sea on the evening of the 19th except the paymaster's stores, which were taken on board on Monday, the 21st. Ensign H. E. Parmenter reported for duty on the morning of that day, and at 4.20 p. m. we left the navy-yard and proceeded to Hampton Roads, where we anchored at 5.35 p. m. Having dispatched our last mail, including a complete descriptive list and muster-roll, we got under way at 8.45, and proceeded to sea under the following orders:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., November 15, 1887.

SIR: For the purpose of carrying out the long-cherished plan of the late Commissioner of Fish and Fisheries, and in accordance also with the provisions of the act of Congress in the sundry civil bill, approved August 4, 1886, providing for the expenses of the voyage of the steamer *Albatross* from New York to San Francisco, you will proceed as soon as the steamer is ready, to San Francisco, conforming as closely as circumstances will permit with the itinerary already agreed upon between you and myself, and reaching San Francisco on or about the 15th of May, 1888. Upon your arrival at San Francisco you will find awaiting you detailed instructions as to the character of the investigations which it is desired to make concerning the fishery resources of the Pacific coast. During the voyage you are authorized to make such stoppages as may in your judgment be necessary, and also, when opportunity offers, to carry on such investigations as, upon consultation with the assistant in charge of the scientific staff, shall seem to be advisable, considering always the limitations of time and of the appropriation.

Instructions for the government of the scientific work to be done during the voyage, so far as it is possible to specify them in advance, have been prepared, and are forwarded herewith, addressed to Prof. Leslie A. Lee, who has been appointed assistant in charge of the scientific staff.

As I have already intimated to you, and in accordance with a letter from him, a copy of which has already been forwarded to you, it is expected that Prof. Alexander Agassiz will join the *Albatross* at Panama, in which case I have to request that all facilities may be offered him for carrying out the scientific inquiry which he has in view, consistently with the purposes and limitations of your voyage.

It is desirable that any hydrographic information which can be obtained without detriment to the Fish Commission shall be forwarded to the Navy Department.

In addition to Prof. Leslie A. Lee, assistant in charge of the scientific staff, the following civilian assistants have been assigned to the vessel: Mr. Thomas Lee, Mr. Charles H. Townsend, and Mr. Dennis M. Cole. * * *

From the time of the vessel leaving the Atlantic coast the regulations in regard to requisitions will be waived and all expenditures will be under your direction. * * *

With my best wishes for a pleasant and prosperous voyage, and for the successful conduct of your investigations, I have the honor to be,

Very sincerely yours,

G. BROWN GOODE,
Commissioner.

Lieut.-Commander Z. L. TANNER, U. S. Navy,
Commanding U. S. Fish Commission Steamer Albatross,
U. S. Navy-Yard, Norfolk, Va.

It is seldom the fortune of men to start on a long voyage under more favorable auspices. The ship was well equipped and thoroughly seaworthy in every respect. She had on board an efficient corps of officers and scientists, and her crew could not be excelled. Many of them were experts in our deep sea-work, having served several years on board. Reference to the foregoing orders shows that we were to proceed to San Francisco, Cal., arriving about May 15, 1888, when we would find awaiting us detailed instructions governing our future action. In the meantime we were to make such scientific investigations en route as might be prosecuted without detriment to the ultimate objects of the voyage.

THE VOYAGE FROM NORFOLK TO SAN FRANCISCO.

The following itinerary, approved by the Commissioner, is inserted here, to show the general distribution of our time, although it was not intended to be followed strictly if it were found advisable to depart from it while on the voyage:

Proposed itinerary.

Port.	Arrive.	Leave.	Days dredging.	Days en route.	Days in port.	Distances.	Average speed per hour.
Norfolk, Va	....	Nov. 20	......	......	......	....	......
Santa Lucia, West Indies	Nov. 29	Dec. 5	1	8	6	1,675	8.7
Bahia, Brazil	Dec. 23	Dec. 26	2	16	3	2,665	6.9
Rio de Janeiro, Brazil	Dec. 30	Jan. 5	0	4	6	795	8.2
Montevideo, Uruguay	Jan. 10	Jan. 14	0	5	4	1,020	8.5
Sandy Point, Straits of Magellan	Jan. 23	Jan. 27	2	7	4	1,330	7.9
Valparaiso, Chili	Feb. 13	Feb. 20	6	11	7	1,500	5.6
Callao, Peru	Feb. 26	Mar. 2	0	6	4	1,270	8.8
Panama, United States of Colombia	Mar. 11	Mar. 17	2	7	6	1,350	8.0
The Galapagos	Mar. 25	Mar. 31	3	5	6	950	7.9
Acapulco, Mexico	Apr. 7	Apr. 13	2	5	6	1,125	9.3
La Paz, Lower California	Apr. 19	Apr. 25	2	4	6	820	8.5
San Francisco, Cal	May 15	....	10	10	......	1,330	5.5
			30	88	58	15,830	7.8

The time under "days in port" is intended to include the necessary delays of coaling and taking in stores, as well as those to be occasioned by the investigations of the naturalists as before explained. Our subsequent movements were governed accordingly, and it only remains for me to record the leading events of our progress toward the Pacific, leaving to the naturalists the task of reporting the scientific results of our explorations. In noticing the casts of the trawl, etc., mention is made of various forms taken simply to indicate the character of the haul without reference to scientific results or pretending to strict accuracy.

Chesapeake Bay to Santa Lucia, West Indies.—We passed the capes of the Chesapeake at 10.35 p. m. with calm, clear weather, light moonlight, and a clear sea. Cape Henry Light was dropped at midnight, thus severing our last connection with the Atlantic coast of the United States. Pleasant weather and smooth seas continued until the 23d, when a fresh breeze sprung up from the ENE., finally increasing to a moderate gale; but being fair wind we looked upon it with favor, as it enabled us to carry sail and economize coal. It died away on the evening of the 26th, from which time until we made Sombrero, at 4.15 p. m. the following day, we had light southerly winds and squally weather. It was our custom to slow the engines every evening after dark for fifteen or twenty minutes, whenever the weather was suitable for surface towing. At 6.50 on the evening of the 27th, after passing the island, we made a haul of the dredge in 406 fathoms, fine gray sand (latitude 18° 30′ N., longitude 63° 31′ W.). A great variety of shells were conspicuous among the different forms, and large numbers of cup-corals and sponges were taken. The weather had been threatening all the evening with heavy thunder and lightning, and rain all around us, but we escaped till about the time the dredge reached bottom, when we were struck by a tropical tempest which raged with slight interruption for nearly four hours, thoroughly drenching everybody on deck and seriously complicating our work of dredging. It was doubtful whether we would save our apparatus; but it was finally landed, slightly damaged, and it proved a fruitful haul. The sun came up bright and clear the next morning, and we availed ourselves of the opportunity to swing ship under steam, observing azimuths on alternate points for compass errors. It was a particularly favorable opportunity, for, being under the lee of Guadaloupe, the sea was perfectly smooth, and, what was equally important, we were on the line of no variation. Having completed our observations we steamed ahead until 9 a. m., when the trawl was lowered in 687 fathoms, ooze (latitude 16° 54′ N., longitude 63° 12′ W.), and landed on deck at meridian, heavily loaded with ooze, which was pretty evenly impregnated with the shells of pteropods and globigerina. The net contained the usual variety of brilliantly-colored crustaceans, holothurians, deep-sea fish, cup-corals, crinoids, sponges, etc. The haul completed, we resumed

our course, anchoring in Port Castries, island of Santa Lucia, at 11.08 a. m., November 29.

A boat was sent for the United States consular agent, Mr. William Peter, who visited the ship, and later in the day accompanied Prof. L. A. Lee and myself in an official call on the governor of the island, to whom we paid our respects, and of whom we obtained permission for the naturalists to make collections.

We coaled ship December 3, taking on board 104 tons of excellent Welsh coal, 29 tons being stowed in bags on the deck. As a coaling station Port Castries has many advantages, and when the harbor improvements in progress are completed it will have no superior in the West Indies. The United States consular agent placed us under many obligations by his advice and assistance.

Santa Lucia to Bahia, Brazil.—At 7.50 a. m., December 4, we left the beautiful little harbor of Port Castries for Bahia, Brazil, and at meridian of the same day cast the trawl in 281 fathoms black sand (latitude 13° 34′ N., longitude 61° 04′ W.), midway between the islands of Santa Lucia and St. Vincent. It caught on rough bottom before it had dragged a fathom, but on getting it on board some very fine specimens were found fastened to the net, among them a small stemless sea lily, *Antedon*, corals, etc. It was evidently no ground for a trawl, so we lowered the tangles, and they had a rough time of it, but brought up numerous specimens of pennatulus, antedons, ophiurans, gorgonians, corals, etc. One little spray of vermilion coral attracted attention. Black fish, porpoises, and flying fish were plentiful, and numerous sea birds were observed feeding in the tide rips and eddies between the islands. The weather was warm, but pleasant, with light winds and smooth sea.

We cast the trawl at meridian, December 5, in 880 fathoms, ooze (latitude 11° 40′ N., longitude 58° 33′ W.), landing it on deck at 3.10 p. m., with numerous archasters, holothurians, a variety of crustaceans, mollusks, etc., many of them apparently being similar to those taken by us on the Atlantic coast of the United States. The surface net was used with moderate success, several specimens of young fish, crustaceans, etc., being taken.

December 6 was marked by variable winds and frequent rain squalls. At meridian we sounded in 2,069 fathoms, ooze (latitude 9° 47′ N., longitude 55° 51′ W.), and proceeded on our course after a detention of forty-five minutes.

The trawl was cast at meridian, December 7, in 720 fathoms, blue mud (latitude 8° 04′ N., longitude 52° 47′ W.), and was landed on deck at 2.33—a water haul, notwithstanding more than ordinary precautions had been taken to insure success. The depth increased probably before the trawl was down; at least that is the only way I can account for the failure.

Easterly winds and squally weather continued and everything above

decks was pretty well saturated. The last bag of our deck load of coal was struck below during the day, much to the relief of every one; it was certainly a great nuisance, but it carried us 640 miles on our course, so we took the dirt and inconvenience philosophically.

A sounding was made at meridian, December 8, in 2,406 fathoms, ooze, (latitude 6° 25′ N., longitude 50° 29′ 30″ W.). We did not expect more than 1,000 fathoms, and intended to get a cast of the trawl, but abandoned the idea, not only on account of the great depth, but a heavy easterly swell and strong current combined made a successful haul improbable.

Hydrographic Office Chart No. 41 has on its face a note—"Discolored water;" and between latitude 5° 00′ and 5° 12″ N. and longitude 46° 43′ a line of three soundings extending NE. by N., and SW. by S., 12 miles with 52, 64, and 68 fathoms. As this was a long way from land and in a region of supposed deep water, I considered it advisable to settle the point, and, deviating somewhat from our course, sounded at 9 p. m. in 1,876 fathoms, ooze (latitude 5° 01′ N., longitude 46° 44′ W.), demonstrating beyond question the non-existence of shoal water in the position indicated. Discolored water may have been seen, as the discharge from the Amazon in the season of floods has been traced much farther to the eastward.

At 11.30 a. m., December 11, we sounded in 2,440 fathoms, ooze (latitude 1° 53′ N.; longitude 43° 00′ W.), demonstrating the fact that deep water approaches the coast southward of the mouths of the Amazon.

The next sounding was made at 10 a. m., on the 14th, in 391 fathoms, sand and ooze (latitude 3° 22′ S.; longitude 37° 49′ W.), and the small beam trawl put over, the strong trades, heavy confused sea, and rapid current, making it unsafe to attempt a haul with the large and more effective one. It came up at 11.50, and among the many specimens were a small octopus, several specimens of *Macrurus*, different from any I had seen; hundreds of red shrimp of various species, *Rhizocrinus*, a sea spider new to us, and many other forms. It was a successful haul made under adverse circumstances, when the loss of the apparatus seemed the most likely occurrence.

We sounded again at 10 a. m. the following day in 1,263 fathoms (latitude 4° 38′ S.; longitude 35° 55′ W.), intending to make a haul of the trawl, but the unexpected depth and boisterous weather prevented.

The first indication of our approach to land was the discovery of a couple of fishermen in a "catamaran," reported by the officer of the deck as two men adrift on a raft. He seemed quite surprised that we did not go to their assistance, and would doubtless have felt that the shipwrecked mariners had been left to their fate, had not the subsequent discovery of many more, both under sail and at anchor, enlightened him as to the nature of this peculiar craft, which he now saw for the first time.

At 4.32 p. m., December 16, we made two hauls of the dredge, fol-

lowed by one with the small beam trawl, in 20 fathoms, coralline bottom (latitude 6° 59′ S.; longitude 34° 47′ W.). Several bright-colored fishes were taken besides bryozoans, mollusks, corallines, and other algæ. The coralline bottom referred to is peculiar and deserving of notice. It is composed of coarse sand and broken or disintegrated mollusk shells, corallines, and bryozoans in equal quantities, often consolidated into large nodules, which are covered with living corallines and bryozoans. Occasionally small pebbles are scattered through the deposit, angular in form, composed of quartz and feldspar, and covered with a deposit of lime, the same material which enters so largely into the composition of the nodules before mentioned. Thus it will be seen that the bottom is composed largely of vegetable growth.

We passed the latitude of Cape St. Roque between 12 and 1 a. m. on the 17th, were off Formosa at meridian, and passed Pernambuco later in the day, when we kept off for Bahia, made all sail to a moderate SE. trade and considered ourselves at the top of the hill, which we had been climbing since we left Santa Lucia, having encountered strong trades dead ahead, with heavy seas and adverse currents, aggregating 270 miles on a daily average of 30 miles.

The trawl was cast at 3.30 p. m., December 18, in 1,019 fathoms, brown clay (latitude 12° 07′ S.; longitude 37° 17′ W.). Everything worked smoothly until we began heaving in, when the trawl, buried in the tenacious mud of the bottom, obstinately refused to come out until the bridle stops parted, allowing it to come up tail first after disgorging its load. There were a few specimens in the net, and the mud-bag and ring-nets presented an interesting contrast in the nature of the bottom deposits brought up. They had all been well buried in the mud, presumably passing through the same deposit, yet one contained a quantity of coarse pteropod ooze and the other fine globigerina ooze, with only here and there a pteropod shell. A *Macrurus*, unknown to us, was among the few specimens in the trawl net; there was a small starfish also, and a flat cup-coral, besides shrimps, sponges, etc.

Numerous flocks of birds were observed following schools of surface fish, and flying fish were constantly scurrying away from the ship. A noticeable quantity of conferva was seen in the water during the day, and a sufficient amount secured for examination.

We arrived at Bahia, Brazil, at 8.50 a. m., December 19. The usual visits were made and returned. One hundred and fifty-six tons of coal were taken on board on the 22d, and at 6.50 p. m., December 25, we got under way and proceeded to sea.

Up to this time we had been using both boilers, with a consumption of 10 to 12 tons of coal per day, which necessitated very light fires—so light in fact that we thought it worth while to try the experiment of one boiler burning as much coal as it would consume economically—from 9 to 10 tons per day, and we left port with only one in use.

Bahia, Brazil, to Montevideo.—The trawl was lowered at meridian on the 26th, in 818 fathoms, ooze (latitude 15° 39′ S.; longitude 38° 32′ 54″ W.), and landed on deck at 3.18, bringing up several species of fish, besides starfish, ophiurans, crustaceans, etc. The quantity of material was small and the mud was completely washed out of the net, showing an entirely different bottom from that encountered north of Bahia, where the clayey mass would not wash through the meshes of the trawl.

Soon after daylight, December 27, we swung ship under steam, observing azimuths of the sun for compass errors and at 7.50 a. m. anchored in the harbor of Abrolhos, where we called to give the naturalists an opportunity of examining the flora and fauna of these out-of-the-way islands. The group is composed of masses of rock rising above the sea, with no living water, scant vegetation, and uninhabited except by the light-house keeper and his assistants. A few wild goats find a precarious existence on the largest island. The group is a favorite resort of sea birds, the naturalists taking eight species. Lizards were plentiful, and a couple of rats were found on one of the uninhabited islands. An enormous *Mygale* was among the most interesting specimens, a spider so large and powerful that it was able to capture and kill young sea birds, upon which it subsisted. Our list of fishes was materially increased by the use of several Bahia fish-baskets, which not only provided specimens, but also supplied the officers' mess with many excellent fish.

We left the islands at 3.55 p. m., December 28, still under one boiler, our experimental run from Bahia having proved satisfactory. Cape Frio was sighted at daylight, December 30, and at 6 a. m. the dredge was lowered in 59 fathoms, blue mud and clay bottom (latitude 23° 08′ S.; longitude 41° 34′ W.), and although the prospect was not encouraging, when the uninviting mass was emptied into the table-sieve, we procured specimens of fish, starfish, shells, annelids, sea-urchins, cup-corals, and the dead shell of a rare brachiopod. About 4 p. m., I observed several patches of light green water, and, as we were standing toward reported dangers, it occurred to me that they might exist and that we were approaching them, but a closer scrutiny as the ship passed through one of the discolored spots, showed that the peculiar tint was confined to the surface or within a foot or two of it, and was caused by a mass of conferva.

On Saturday, December 31, we ran a line of soundings over reported dangers marked on the chart as follows:

⊕ ? Edith Rose, 1865; 17 fathoms, sand, in latitude 25° 45′ S.; longitude 44° 44′ W.

⊕ ? Rock just awash; seen February, 1811, by a pilot of Bahia named Medeiros. Position, uncertain; latitude, 25° 41′ S.; longitude, 44° 48′ W.

⊕ Medeiros Rocks, latitude 25° 32′ 30″ S.; longitude 44° 59′ W.

This shoal is plotted in the direct route of commerce and is a standing menace to navigation. It has been searched for by men-of-war of various nations, but, as the negative soundings indicate, they were not supplied

with deep-sea sounding apparatus and had no means of demonstrating the contour of the bottom, which is the only effective means of determining the non-existence of submarine dangers.

Although not on a surveying voyage, I thought it would be unjustifiable to pass over supposed dangers of such serious nature with a ship perfectly appointed for deep-sea investigation without settling beyond question their existence or non-existence. This we have done, and a reference to the table of hydrographic soundings will show a regular and gradual increase in depth from the coast to the position assigned them, where we found between 800 and 900 fathoms, globigerina and pteropod ooze. There was no indication of change in depth or character of bottom. These soundings were made during fine, clear weather, the positions determined by good astronomical observations and the surface indications were observed by a lookout at the mast-head, whose line of vision included 12 or 15 miles in every direction.

The light green conferva, first encountered on the 30th, was seen again while sounding over one of the positions assigned to the Medeiros Rocks, and it occurred to me that these algæ might be peculiar to the locality, and have given rise to the various reports of shoals. Conferva is of common occurrence on the surface of the sea, but its usual color is buff, brown, or even red. I never saw it of this peculiar light green hue before.

The *Albatross* was in latitude 27° 54′ S., longitude 47° 03′ W., at meridian, January 1, 1888. We were just emerging from the heat of the tropics, and the cool southerly winds effected a most grateful change in the temperature. An occasional school of skip-jacks was observed, besides other surface fish. Among the birds were two or three large white-breasted petrels, which the naturalists vainly attempted to capture. We saw our first albatross on the morning of the 2d, in latitude 30° 33′ S., longitude 49° 29′ W. The same afternoon a sounding was made in the position assigned to Ried's Bank, latitude 31° 05′ S., longitude 49° 45′ W., in 78 fathoms, which agrees with depths surrounding it, and indicates the non-existence of a bank in that position.

Land was seen during the afternoon of the 3d, and at daylight the following morning Ponta del Este and the coast to the northward were in sight. The rounded hill-tops and sand downs presented a rather disappointing appearance for a region possessing so many agricultural resources. The character of the country changed after passing Maldonado, an occasional forest or grove improved the landscape, and extensively cultivated estates relieved the impression of sterility acquired from a first view of the coast.

We anchored in the outer roads of Montevideo, near the United States Flag-ship *Lancaster*, at 2.50 p. m., January 4, received pratique at 6 p. m., and at daylight on the 5th moved to the Inner Harbor, where we found the United States steamers *Alliance* and *Tallapoosa*, besides several foreign men-of-war.

The usual official calls were made and received. The weather was boisterous, and a heavy swell made communication by ship's boats exceedingly uncomfortable. A southwest gale (pampero) sprung up about noon on the 8th, and continued through the following day, cutting off communication with the shore. Coal began to come alongside on the morning of the 10th, in canvas bags, containing about 600 pounds each, the lighters having a capacity of 30 tons. It was hoisted aboard rapidly by the steam winch, and at 6 p. m. we had received 115½ tons, for which we paid $8.44 per ton, American gold.

Montevideo to the Straits of Magellan.—We left Montevideo on the evening of the 11th, and the next morning lowered the trawl in 11 fathoms, sand and shells, 25 miles NNE. ½ E. (magnetic) from Medano Point, following it with two more hauls, covering a space of 6 or 8 miles in a southerly direction, finding the same depths and general character of bottom. The hauls were very rich in variety of forms. Several live oysters were also taken, seemingly in good condition, and of fair size.

A successful haul of the trawl was made on the afternoon of the 13th. Porpoises were seen in great numbers, and the engines were slowed for a few minutes while an attempt was made to strike one with a harpoon, but they kept out of reach. Albatrosses, gulls, petrels, and other sea-birds hovered over them in large flocks.

The weather was clear and pleasant until 4 p. m., when the sky became overcast, and a light low-lying scud flew rapidly over the mast-heads, with distant lightning, the whole aspect indicating the near approach of a gale. The officer of the watch seemed quite undisturbed until the wind suddenly shifted from SE. to NW., taking the ship by the lee with all sail set. Luckily the squall was not heavy, and the canvas was taken in without loss. The wind veered around the compass twice within two hours, and the barometer oscillated rapidly between 29.84, and 29.72. The wind finally settled about SE. with clearing weather.

A successful haul of the trawl was made about noon, January 14, in 43 fathoms, dark sand and black specks. Among the most notable specimens were a number of fish resembling sea-bass in size and general form, although the external markings were quite different. We had them fried and boiled, for the table, and found them excellent, the texture and flavor of the meat being not unlike bass. The first floating kelp was seen during the evening.

At 11.30 a. m., January 15, the trawl was lowered in 51 fathoms, green mud, fine sand, and a large number and a great variety of species were taken. Among the fish were whiting, hake, flounders, and some species not recognized. The small whiting were very good pan-fish. The large surface net was towed as usual while the trawl was down, but, with the exception of a few minute crustaceans, very little life was found on the surface.

The sudden changes in surface temperature between 45° and 50° S.

latitude have been commented upon by navigators, it being asserted by some that bad weather follows a fall. It is a region of sudden changes and frequent gales in winter, and it would not be strange if such were the case when this phenomenon is likely to occur any day, or several times a day. We experienced notable variations in surface temperature, yet the weather continued almost perfect, owing probably to its being the summer season. These fluctuations in surface temperature are caused by a cold submarine current from the Antarctic, which occasionally finds its way to the surface.

A successful haul of the trawl was made at 11.30 a. m. on the 16th, and another at the same hour on the following day. High land back of Cape Virgins was made at 1.45 p. m., and at 4 we made another successful haul of the trawl in 31 fathoms. Trial lines were put over on Sarmiento Bank, but no fish were taken, owing probably to the rapid drift of the ship over the bottom. The small beam trawl was allowed to drag a few minutes, and new and interesting specimens were taken, although the net came up a mere wreck.

The wind gradually increased from the northwest, until at 5 p. m. it was blowing a moderate gale, with heavy swell, which continued until we rounded the Cape. We steamed ahead as soon as the trawl was up, and at 7 p. m. anchored for the night off Dungeness. The wind moderated after sunset, and was followed by rainy, misty weather.

Dungeness to Sandy Point, Straits of Magellan.—We were under way at 4 o'clock the following morning, and made a haul of the trawl at 4.30 a. m., in 17 fathoms, entered the first narrows at 8, groping our way through the rain and mist, and at 9.41 cast the trawl again, in mid-channel, in 29 fathoms, sand and stones, and made a successful haul, although the flood-tide was running with great force.

Extensive buildings belonging to Wood's sheep ranch were observed on Delgada Point, excellent guides for vessels making the anchorage as well as for those entering the Narrows, when Direction Hills and other landmarks are shut out by fog. The passage through the Narrows was made without difficulty, the weather clearing as we approached the western entrance. A successful haul of the trawl was made near Triton Bank, in 21 fathoms, sand and pebbles, at 12.10 p. m., and at 1.25 we anchored in Gregory Bay.

Felton's sheep ranch lies north and west of the bay, the buildings being conspicuous when approaching the anchorage. Sheep-grazing is a new and very profitable industry, and most, if not all, of the Patagonian coast from Cape Virgins to Sandy Point is now utilized for that purpose. The wilds of Terra del Fuego have even been invaded by the sheep-graziers, they having located on some of the more accessible islands on the south side of the Straits of Magellan, which are well adapted for their purpose. The Indians seem disposed to contest the invasion, and more or less trouble is anticipated before the graziers are allowed to occupy their newly discovered pastures without molestation.

The naturalists, with a party of volunteers, left for the purpose of shore collecting, as soon as the anchor was down, returning toward sunset, with fair results. A seining party took sufficient mullet to supply the ship, but caught very few of the other species. Frequent showers made this work rather disagreeable, but did not deter the naturalists or volunteers, who, after their long confinement on board ship, were wild for a run on shore.

The collectors left at daylight the following morning, and returned a little before noon, well satisfied with their first exploration on the coast of Patagonia. We got under way at 1 p. m. and lowered the trawl a few minutes later in 20 fathoms, sand and pebbles, making a successful haul; then steamed through the second Narrows, and at 3.40 p. m. anchored in 7 fathoms off the south side of Elizabeth Island. A breeze had sprung up from the southwest as we were getting under way, which increased rapidly to a moderate gale. It continued until we reached our anchorage, and prevented further work with trawl or dredge.

A large party of collectors left as soon as the anchor was down, and on their return reported a rich field for exploration. There was a variety of birds on the island, including ducks and wild geese. *Bernicla Magellanica* was plentiful, and on the southeast extremity was a tern rookery, where millions of the pretty little sea-birds were nesting. It was located on a plateau about 20 feet above the sea, and covered many acres. The nests were on the ground, and exceedingly simple in structure, being composed of a little grass and a few dried twigs, hardly sufficient to keep the eggs from rolling about. They contained from 1 to 3 eggs, and were so close together that it required the greatest care to walk among them without crushing eggs or the young birds that thickly covered the ground. The old birds abandoned their nests as the exploring party approached, literally filling the air, and scolding at the top of their piercing voices, the united protest of these millions of throats being little short of deafening. This, in addition to other disagreeable features, such as their locality directly beneath countless numbers of sea-birds frightened from their nests, was sufficient incentive for the explorers to seek other quarters as quickly as possible.

Elizabeth Island is now occupied as a sheep ranch. It has not been inhabited by Indians for many years, although the early Dutch navigators reported them on the island in considerable numbers, and numerous shell-heaps of great extent covered with soil from 6 inches to 3 feet in depth indicate the existence of a large population at some remote period.

January 20 was a pleasant day, and we made the most of it by sending a strong working party on shore under the direction of Professor Lee, with shovels, to excavate and explore shell-heaps. Messrs. Townsend, Miller, and myself went to Sta. Marta Island in the hope of finding a colony of penguins or a few antarctic sea-lions, but we encountered instead a rookery of cormorants, covering several acres on the central

portion of the island. The elaborate nests were circular in form, 16 to 18 inches in diameter at the base, 6 inches in height, and ten inches in diameter at the top, hollowed out and lined with grass and small twigs. They were so placed as to get the greatest possible number in a given space, the nests of one row alternating with those of the next with great regularity. This applies more particularly to the central portion, as the nests on the outskirts were irregularly placed, having open spaces of several feet in extent at times. There was great commotion among the birds as we approached, the more timid taking to their heels, or wings, according to individual ideas of the necessities of the moment, but the great mass remained until we approached within fifty feet, enabling us to take several photographs.

One nest might contain from one to three eggs, the next a couple of young just hatched, the soft, velvety skin as black as jet, and no sign of feathers, while in a third might be seen two or three half-grown birds covered with a uniform growth of down nearly black. The young birds were unable to fly, and the old ones seemed disinclined to use their wings at close quarters. When a rush was made by the men they simply scurried off en masse, leaving the young, who seemed to have little or no fear of us, several of them taking food from our hands without the least hesitation.

Another species was found nesting on the cliffs, and could be distinguished by their black necks, those of the rookery being white. Specimens of eggs and birds, adults and young, of both species were collected.

There were a few wild geese, an occasional hawk, and many gulls on the remote points. These last were nesting, their eggs lying on the ground without the least attempt at nest-building, the young being left to hide themselves as best they could when we approached. They concealed themselves in the grass, under a bush or stone, or even on the beach, while the older ones took to the water and paddled about under the matronage of an old gull.

We found a shell heap on the island, from which several stone implements and bones were procured. Professor Lee met with deserved success in his exploration of the shell heaps of Elizabeth Island, and the others did very well in general collecting.

January 21 commenced with weather overcast and light westerly winds, which backed to SW. between 5 and 6 a. m., increasing to a moderate gale at 11. This made communication with the shore so difficult that the parties were called on board, and at 2.40 p. m. we steamed to Laredo Bay, anchoring there at 4.20. We expected to find it smooth, as the wind was off shore, but there was sufficient surf on the beach to make landing unpleasant; so the collectors were obliged to remain on board until 4 o'clock the following morning, when they landed and commenced work in various directions.

Cape Negro forms the northeastern boundary of Laredo Bay, and is covered with an irregular forest growth. It may, in fact, be considered the dividing line between the comparatively low treeless coast of eastern Patagonia, and the mountainous, heavily-wooded regions to the westward. A deep valley back of the bay and the surrounding heights were occupied as cattle ranches, large herds being seen a short distance inland. Horses, cattle, and sheep graze the year round, and require little attention, except the protection of the last from wild beasts. The seine was hauled with fair success, as far as procuring specimens was concerned; half a dozen mullet were all the edible fish taken.

The barometer took one of its inexplicable Antarctic flights on the 22d, ranging from 29.58 to 30.32 within twenty-four hours, pleasant weather prevailing meantime.

At 10 a. m., January 23, we got under way, stood out to the middle of the straits, and made two successful hauls of the trawl in 60 and 77 fathoms. Large numbers of specimens were procured, but there was a notable absence of fish. As soon as the last haul was completed we steamed to Sandy Point, anchoring off that place at 1.20 p. m.

We were visited by the health officer and granted pratique without delay. Official calls were exchanged with the governor of the province, Sr. Francisco R. Sampaio, who extended every courtesy, and made our stay at Sandy Point very pleasant. Sr. Ramon Lista, governor of the Argentine Colony of Santa Cruz, arrived soon after the *Albatross*, and calls were exchanged. We also met the governor of the Argentine Colony of Ooshooia, in southeastern Terra del Fuego, who informed us that shipwrecked mariners need not fear the natives east of Cape Horn. On the contrary, they could be depended upon to render all practicable aid.

The naturalists expressed a wish to have some specimens of the Antarctic sea-lions for the National Museum; so, after having made inquiries on the shore, Mr. Townsend and I left the ship in the steam-cutter at 8 a. m., on the 26th, for St. Peter and St. Paul Rocks, latitude 53° 43′ S., longitude 70° 44′ W., about 35 miles from Sandy Point. They are on the south side of the Straits, about 1 mile in length, a quarter of a mile in width, 10 feet above high water, and connected by a narrow neck, which is awash at half tide. They are quite barren, with the exception of a few bushes on the higher part of the largest islet. Nearing the rocks we saw a number of seals, or sea-lions, hauled out on a steep, rocky beach, just above high water, and, landing on the opposite side, we worked our way to a favorable position, about 200 yards from them, fired at the word, killing four at one discharge. One fell into the water and sunk, so we secured but three. They proved to be fur seals on closer inspection, entirely different from the animals we were in search of, but we skinned them, nevertheless, and preserved one skeleton. We shot several birds, and a number of fossil shells were chiselled out of the rocks.

A canoe containing two men, three women and a child came off from Dawson Island, and went first to the cutter begging for tobacco and bread; but the crew distrusted their motives, so, after giving them a little tobacco, made a suggestive display of an ax, hatchet, and a double-barreled shot-gun, which caused the Fuegians to beat a hasty retreat. The two men landed and watched the process of seal-skinning, appropriating the carcasses, which they carried to the canoe for food, while one woman increased the supply of their larder by capturing a dozen or more half-grown cormorants from a rookery near by. Eggs which she took from the nests were eaten raw with evident relish. Another woman was bailing the boat, while the third busily employed herself over a fire, which was built on a bed of sand in the bottom of the canoe. She was cooking young cormorants and seal meat, on which they were regaling themselves when we left the rocks.

We had strong winds and squally weather during the day, and as there was no harbor nearer than Port Famine on the Patagonian side, we steamed across the straits and anchored in a snug little bay for the night, where we were protected from wind and sea. We were fortunate in finding a secure harbor, as it came on to rain and blow heavily, getting up a sea that would have made us exceedingly uncomfortable in an open bay in the straits. As it was, we passed the night under our water-proof canopy without interruption or discomfort, except that incident to the cramped quarters of the boat.

The morning was occupied in shore collecting until 10 a. m., when we started on our return, encountering a fresh breeze and heavy swell after leaving Port Famine. A landing was made at the southern extremity of Fresh-water Bay, where the country was covered with a dense forest and many flowers. The fuchsia was seen growing wild, some of the bushes being 3 inches in diameter, and 15 feet or more in height. Embarking again after an hour's tramp, we reached the ship at 6 p. m. Several large forest fires were seen sweeping over the country, leaving utter desolation behind, houses, barns, fences, and growing crops being destroyed.

The climate and soil are well adapted to the growth of many vegetables, were it not for the heavy winds, which blow the rich black loam away, where the sward is broken for cultivation. Gardens and cultivated fields are surrounded by high fences, to break the winds, except in rare instances, where surrounding forests or the peculiar conformation of the land serve the same purpose.

Sandy Point has a population of about 2,000, and is increasing in size and commercial importance since the occupation of the Patagonian coast for sheep and cattle grazing, and the colonization of southeastern Terra del Fuego by the Argentines. Its central location makes it a convenient stopping place for steamers passing through the straits, and it is the distributing point of all that region. A recent fire had destroyed the public buildings, including the Governor's residence, and we

found him and his family occupying very cramped quarters in a small one-story wooden structure. A large iron hulk was moored off the settlement, on board of which they usually kept a stock of coal. We had depended on it for a supply to carry us to Callao, past the cholera stricken ports of Chili, but for the first time in years they were without a ton, the coal famine on the Pacific coast having caused an unusual demand, while the loss of one vessel, and the non-appearance of another, made it impossible to replenish their stock.

Sandy Point to Port Churruca, Straits of Magellan.—We received a mail on the 31st, and no coal arriving, made preparations to proceed to Lota for our next coaling port. We were under way at 2.40 on the morning of February 1, steaming to the westward through the mist and rain which partially obscured the land; upon entering Famine Reach it cleared somewhat, and though we had occasional showers, the shore was generally visible.

Cape Froward, the southern extremity of the continent, was passed at 9 a. m. with the usual accompaniment of rain and sleet, and furious williwaws, which came tearing down the mountain sides with almost the force of a hurricane.

Passing Fortesque Bay at 11.30 a. m. we entered English Reach, where a strong northwest wind was encountered. Several parties of canoe Indians shoved off from York Point, and waited our approach, clamoring for tobacco and ship's bread. We slowed down and allowed them to come alongside, at the request of the naturalists, who immediately struck up a spirited barter for articles destined for the National Museum. They were ready to exchange everything in their possession, except their canoes; spears, paddles, domestic utensils, clothing, and ornaments belonging to men and women were offered in trade. They even expressed a willingness to sell their children. After a delay of a few minutes the canoes were cast off against the earnest protests of their occupants, and the *Albatross* proceeded on her course. We arrived at Borja Bay at 2.15 p. m., and anchored, to allow the naturalists to examine the shores. It is a time-honored custom for vessels passing through the straits to leave a sign-board in Borja Bay, generally nailed to a tree, giving the ship's name and date of arrival, besides other information of interest to the mariner. Following this example, the *Albatross* left the usual record nailed to a tree, where it could be read with an ordinary marine glass from the deck of a vessel at the anchorage. We were again visited by canoe Indians, who kept up a lively barter with the naturalists and others until near night, when they camped on shore.

We were under way at 4 a. m., February 2, and steaming out of the bay, groped our way through Crooked Reach in a fog and mist so dense that we could not see more than a ship's length. It cleared gradually after passing Field Anchorage, about 7 a. m., revealing several fine glaciers, Mount Wyndham, Mount Wharton, and Mount Hart Dyke, being among the most impressive.

A successful haul of the trawl was made at 11.27, off Chapman Island, Sea Reach, in 369 fathoms, after which we started ahead and arrived at Nassau Anchorage, Port Churruca, at 2.12 p. m., anchoring in 17 fathoms, rocky bottom, near the center of the bay.

The various anchorages in Port Churruca are perfectly land-locked, and surrounded by high and precipitous mountains, down which furious squalls rush whenever it is blowing heavily outside. The interstices of the rocky bottom are filled with tenacious mud, through which the bight of the long scope of chain is dragged before the full strain is taken by the anchor; otherwise it would be unsafe for vessels to attempt to lay out heavy gales in these small rock-bound basins.

It was remarkably quiet on the day of our arrival, and, although rapidly flying clouds could be seen overhead, scarcely a breath of air reached us. Fierce and frequent williwaws came down upon us the following morning, first from one direction then from another, sheering the vessel about in the most alarming manner, yet, being of momentary duration, they usually passed before the cable was straightened. Snow and ice were seen on the mountains, and on the south side of the Cosmo Arm a beautiful glacier extended far down from the summit. Many fresh-water streams poured down from the height and in the old days of sailing ships would have been convenient watering places.

A portage about 300 feet in length was found at the head of Lobo Arm leading to a bay of considerable extent, not shown on our charts. It may cross Desolation Island from the vicinity of Beauclerk Islands, or is possibly an extension of Puchachailgua Inlet. There are evidences of its having been used by others than Indians, large trees having been cut away with axes in the hands of experts, and sufficient logs laid to prevent the boats miring in the marshy soil. The naturalists added materially to their collections from land and water and the photographers obtained some interesting views.

The charts and sailing directions of the Straits of Magellan furnished by the Hydrographic Office were sufficient for the purposes of navigation, and although we had thick rainy weather much of the time, we found no difficulty in locating the ship, except when making the first narrows, and there we could have found anchorage if desired.

Port Churruca to Port Otway, Chili, by the inland passage.—We left Port Churruca at 1.30 p. m. February 3, and, on reaching the channel, found it blowing a moderate gale from WNW. with a heavy sea. Passing Tamar Island at 3, we kept off for Smyth's Channel, set double reefed fore topsail and fore staysail, and made the passage in good time, considering we were using but one boiler.

We passed Pearse Rock at 6 and Alert Rock a few minutes later, both showing above water, and easily seen in moderately clear weather. Reaching Otter Bay at 7.10, we anchored for the night in 9 fathoms, mud, and veered to 30 fathoms. It is an excellent harbor for small craft, but is rather cramped for vessels over 250 feet in length. An-

chorage on the ridge to the southward of the islands would be preferable for large vessels. The plan and sailing directions for Otter Bay leave little to be desired, but should the weather be thick, making it difficult to distinguish the entrance, it might be mentioned that the crosses and sign-boards on Bedwell Island will settle all doubt.

We were visited by canoe Indians, who camped on Cunningham Island for the night, and next morning entered into a spirited trade with the naturalists, who, for a few trinkets obtained about all the movable property they possessed, except their canoes, which they declined to part with at any price.

Leaving our comfortable harbor at 10 a. m., February 4, we steamed through Gray Channel against a strong northerly wind, the frequent heavy squalls coming down with the force of a gale. Welcome Bay was passed at noon. Bessel Rock and Cloyne Reef showed above water and were seen at a distance of at least 3 miles. Clearing Victory Pass, the Cordilleras of Sarmiento, with their glacial ice caps, burst upon our view as the clouds lifted for a moment. The trawl was cast off Redfern Point, Newton Island, in 348 fathoms, blue mud, and a successful haul made, notwithstanding it having caught on a rough coral patch, which tore the net badly.

The strong winds of the morning moderated towards noon, but, after clearing Farquhar Pass and entering Sarmiento Channel, they came down with renewed force, retarding our speed until it became doubtful whether we would be able to reach our anchorage before dark.

Numerous errors in the charts became noticeable from S. Bartolome Point. The group of islands between Lecky Retreat and Hamilton Point are not shown, and those to the northward of Piazzi Island are not properly located. Prominent points would not cut in, and the topography was entirely omitted on the charts, matters of little importance in that particular locality if it is clear, but it would be rather confusing for a stranger, in thick weather, to find himself near a group of islands when his chart shows a clear, bold coast.

We reached Mayne Harbor at dusk and anchored in the outer bay, which is quite secure, although more exposed than the landlocked inner harbor. We passed the Italian man-of-war *Christofo Columbo* about noon, steaming to the southward, homeward bound.

The wind was from NW., light to moderate on the 5th, with frequent squalls of wind and rain sweeping across the harbor from various directions, causing the ship to swing around her anchor in a most lively manner, but the bottom being a soft mud, no harm resulted.

The collectors were out all day in spite of the rain; in fact, we had become so accustomed to it that we seldom allowed it to interfere with our work. Something of an excitement was caused by the absence of two of the collectors, who failed to return at sunset, it being a general rule that they should all be on board at that time. Darkness came on and still they were absent. The wind increased as the sun sank below

the horizon, and the rain poured down in torrents. A strong search party left the ship and soon found the missing men, who had carelessly strolled so far away that they were unable to return before dark, and were wet to the skin, cold and hungry. The naturalists made valuable additions to their collections, both from land and water.

We left Mayne Harbor at 4 a. m. on the 6th, the weather still squally, with snow and sleet. Two successful hauls of the trawl were made in Sarmiento Channel, and at 10.40 we anchored in Latitude Cove, in 24 fathoms, mud, where we remained until the following morning in order to give the naturalists an opportunity to examine the locality. The plan and sailing directions for Latitude Cove are all that could be desired for making that snug and convenient anchorage.

The morning of the 7th was thick and rainy, with squalls of snow and sleet. We were under way at 4.35, and after leaving the cove, steamed to the position of a kelp-covered rock reported in midchannel between Cape Charles and Europe Point, but saw no indication of shoal water. We did, however, see a patch of kelp extending off Blanca Point, the northern extremity of Latitude Cove, outside of a line drawn from Cape Alexander to El Manchon.

We were obliged to depend mostly on compass courses, until, between 9 and 10, the fog lifted, and although it remained overcast and squally, we had no difficulty in recognizing landmarks. Passing Cape Somerset at noon, we were near Grappler Reach at 5 p. m., when, off Chill Point, in Eyre Sound, a small iceberg was discovered a mile or more from the nearest land. Our ice-house was empty, and with a tropical voyage before us, we looked upon this opportunity of filling it as providential. Steaming alongside, we got a line fast, and a few minutes sufficed to give us about 7 tons, all we could stow, of excellent ice, which lasted until our arrival in Panama.

We anchored in Port Grappler at 7.52 p. m. in 9 fathoms, mud, an excellent harbor, and easy of approach. The chart of Grappler Reach is simply a reconnaissance, but the channel is clear, and one can not go amiss having once entered it. It was still rainy and squally when we anchored, but the wind came out from the southward during the night, bringing clear weather.

We left Port Grappler at 4.30 on the morning of the 8th, and steaming to the northward, passed through Indian Reach and English Narrows without difficulty. The short turn around Mid Channel Island and Caution Shoal is the only really difficult navigation in the western Patagonian channels, and it would be imprudent to attempt this with a heavy vessel, except at slack water or with a head tide. The wreck of a German steamer was seen on a reef off the south end of Newton Island, near Eden Harbor. We saw nothing of the kelp-patch reported by H. B. M. S. *Zealous* off Greville Point, the southern entrance to Eden Harbor, but it might have been towed under by the tide. Quite a large number of fur-seals were hauled out on the small islets of the

Coradonga Group, but they took to the water as soon as the *Albatross* hove in sight, experience having taught them to give passing vessels a wide berth.

A successful haul of the trawl was made in 196 fathoms, blue mud, 1½ miles to the southward of Direction Islands, and another in 449 fathoms, in Messier Channel, 2½ miles N. E. ½ E., magnetic, from Sidney Point, Black Island.

We swung ship under steam from 3.50 to 4.30 p. m., then ran into Island Harbor, and anchored for the night in 20 fathoms, mud. It is a good harbor for vessels of the size of the *Albatross*, but it can hardly be recommended for heavier vessels, on account of its limited space and the difficulty of turning. Anchorage may be found outside of the harbor in ordinary weather. The naturalists had several hours on shore and made some additions to their collections, but found the fauna and flora closely resembling that which we had seen farther south.

We were under way at 4.20 the following morning, and steaming through Messier Channel crossed Tarn Bay and the Gulf of Peñas to Tres Montes Gulf, made two hauls of the trawl in Holloway Sound in 57 and 61 fathoms, then steamed to Port Otway and anchored in 7 fathoms, sand and mud. The weather was beautifully clear, giving us a magnificent view of the snow-capped Andes during our run across the Gulf of Peñas. We were surrounded by snow-covered heights in the Straits of Magellan and the western Patagonian channels, yet our view was so restricted by thick weather and intervening mountains that we saw comparatively little of them. On this occasion, however, there was spread before us a vast extent of the Andes, whose gigantic peaks were seen towering one above the other far into the region of eternal snow and ice.

Port Otway was found to be an excellent harbor, with particularly good facilities for procuring wood and water, while in the inner basin a vessel would be entirely protected from the ocean swell and find a secure haven in case extensive repairs were required.

The naturalists, with many volunteers, were soon scattered in every direction, and returned at sunset laden with many new and valuable specimens. They were very enthusiastic over the region, declaring it to be rich in life, both animal and vegetable, specimens being found peculiar to the temperate and frigid zones. Familiar forms in the Straits and western Patagonia grow more luxuriantly, and others unknown to that inhospitable region were found in abundance. Forest trees were larger, straighter, and of greater variety, and while the surface was generally covered with mosses, it was not in a state of complete saturation, as we found it farther south. The weather was milder, the sun shining all day without rain or fog; in fact, everything gave evidence of our approach to a temperate climate.

We remained at anchor during the 10th, to enable the naturalists to make further investigations in a region of such unusual interest to them.

The weather continued clear and pleasant in the harbor, although it was foggy outside for several hours. I made the circuit of the bay during the afternoon, and found the shores heavily timbered, beeches predominating and growing to the water's edge, often overhanging. Fresh water streams were frequent and distinguishable by small sand beaches off their mouths. The rock formations differed from those of the Straits and western Patagonia, and in place of the universal granite, conglomerates were conspicuous, and trap was of frequent occurrence, with an occasional thin vein of quartz.

Fur seals, blue heron, humming-birds, wood-peckers, and parrots were seen, and among the specimens brought in by the collectors were wild geese, penguins, cormorants, hawks, etc. Fish were plentiful, several species being taken with the seine and hand-lines. Two large squid were caught, one of them 5 feet 2 inches, and the other 5 feet 7 inches in length, both of the same species, which was new to us.

Port Otway to Lota and-Tomé, Chili.—We left Port Otway at 4.20 a. m., February 11, and rounding Cape Tres Montes proceeded on our course to the northward under steam and sail. A successful haul of the trawl was made at 4 p. m. in 1,050 fathoms, and while the ship was under low speed three fine albatrosses were taken with hook and line. They measured from tip to tip of wings, 10 feet 7 inches; 10 feet 3 inches; and the smallest 10 feet.

A haul of the trawl was made between 2.40 and 6. p. m., February 12, in 1,342 fathoms, green mud, and although the net was badly torn, quite a number of valuable specimens were brought up. The substance encountered on the bottom was mud and clay, cemented by carbonate of lime into masses from one-fourth of an inch to 3 inches in thickness, underlying a thin coating of mud. The mass was perforated with holes made by burrowing animals, and could be broken and crumbled in the hand, yet it had a slight ring under the hammer. It closely resembled the formation encountered by us off the capes of the Delaware and seems identical with the "tosca" of the east coast of South America. The trawl was cast at 3 o'clock p. m. on the 13th, in 1,287 fathoms, green mud, but failed to reach the bottom, a few red shrimp only being found in the net.

Land was seen to the southward of Lota Bay at daylight on the 14th, but was soon obscured by a dense fog. At 9.40 a. m. the trawl was cast off the entrance to the bay in 677 fathoms, yellow mud, and landed on deck at 12.47 p. m., after long and tedious efforts to get it off the bottom with its enormous load of mud, then to wash out sufficient to enable us to hoist the remainder on board. It turned out one of the richest hauls of the cruise, which compensated somewhat for the long delay. We steamed into the bay as soon as the trawl was landed, taking the passage south of Sta. Maria Island, and anchored in the harbor of Lota at 4.55 p. m., in 7 fathoms, about one-third of a mile south of the iron pier. The captain of the port visited the ship and granted

us pratique. He informed us that cholera was prevalent in many places in Chili, but Lota was considered healthy. Such precautions were adopted as the surgeon considered necessary, and we had the satisfaction of leaving the country without a case of sickness of any kind.

From a distance the several anchorages in the bay looked much alike, but on nearer approach Lota was recognized by the light-house near the extreme point of the elevated peninsula which forms the northern boundary of the bay. It is a conspicuous object, standing in the Cousiño Park, its white cylindrical tower contrasting strongly with the two huge chimneys of the smelting works and the dark background of hills in rear of the town. The peninsula itself, on which stands the splendid mansion of the Cousiños, surrounded by its beautiful park-like grounds and heavily wooded avenues, is an unmistakable landmark. There are several piers, and it might puzzle a stranger to recognize the one referred to in the sailing directions. It is the first on entering the bay, is of iron, and belongs to the coal mines. Others will be seen near the smelting works, and a little farther on a breakwater is in process of construction, its dark sides contrasting with the white sand beach in front of the town.

I returned the call of the captain of the port on the following day. We coaled ship on the 17th and 18th, taking on board 171 tons. There was a thick fog during the morning of the 19th, but it cleared about 11 a. m., and at meridian we left the harbor and steamed to Tomé, where we anchored at 5.50 p. m. The naturalists made some collections in Lota, and used the seine about the beaches of Tomé; otherwise there was but little communication with the shore.

Tomé, Chili, to Panama.—We were under way at 2 p. m., February 20, and when clear of the land made sail to a fresh southerly breeze, which, with the consumption of 10 tons of Lota coal, gave us a speed of 200 miles or more per day.

We first saw flying-fish in the Pacific in 33° S. latitude. Albatrosses were still following us and an occasional petrel was seen. A sparrow hawk hovered about the ship for several hours, lighting on spars and rigging. A school of sperm whales was seen moving leisurely about, and patches of floating kelp were passed at frequent intervals through the day. We carried southerly winds until February 22, latitude 30° S., when it fell calm and we began to look for the SE. trades. The surface temperature rose from 59° in Lota to 75° at meridian, indicating that we were to the westward of the Humboldt current.

The surface net was put over on the evening of the 24th, in about 23° S., with fair success. Porpoises played about the vessel for a few minutes, but kept out of the reach of harpoons. Albatrosses and gulls had left us, and two or three species of petrels were the only birds seen during the day. Nothing of interest occurred until the following morning, when half a dozen or more fish were discovered following the vessel. They were about 18 inches in length, their bodies round and slim,

their general form being somewhat like that of a gar. Attempts were made to capture one, but they disappeared without noticing the tempting baits thrown to them.

We took the SE. trades on the 26th, in latitude 17° S. Life became more abundant in sea and air as we approached the equator. Flying-fish were swarming about us night and day, followed by porpoises, dolphins, man-of-war hawks, and other enemies. Petrels of three or four species were common, and boobies lit on spars or rigging occasionally for a quiet nap. Huge turtles were frequently seen asleep on the surface or scurrying away from the ship. Our first view of the tropic bird in the Pacific was in 17° S.

We lost the trades March 1, in latitude 4° S. They were light all through, and we were disappointed in not receiving more assistance from them. The surface net was towed for fifteen minutes at daybreak on the morning of the 1st, with satisfactory results, several new forms being taken, besides many with which we were familiar. A successful haul of the trawl was made at 3 p. m., March 2, in 401 fathoms, green mud, off the coast of Ecuador. The haul was completed at 5.02, at which time we started ahead full speed. Three minutes later A. E. Anderson, coxswain, fell overboard from the rail forward of the fore rigging while working about the trawl net. A life-buoy was thrown to him as he passed the stern, the engines were stopped and reversed, the life-boat lowered nearly to the water and manned, but not detached. When the vessel gathered stern board she was steered by helm and engines to the man, who was then taken in the life-boat as she hung from the davits, and hoisted to the rail, the vessel starting on her course again after a delay of five minutes.

After our departure from Lota we traversed upward of 2,000 miles without using trawl or dredge, or even taking a sounding. As this is quite foreign to our usual custom, it may not be out of place here to explain. Cholera raged in Chili and all South American countries quarantined against her ports. There was no coal at Sandy Point, consequently we were obliged to call at Lota for a supply, thereby incurring the penalty of exclusion from all coaling stations thence to Panama, a distance of about 3,000 miles. While we would not hesitate to add even another thousand miles to the steaming capacity of the vessel with a good quality of fuel, we did not feel at all confident of our ability to make the run with Lota coal, of which we knew nothing personally and about which we had seen bad reports. So we made the best of our way toward Panama until March 2, when we found the supply of fuel would permit us to resume our usual explorations en route.

The island of Plata and the highlands of Ecuador were seen shortly after daylight, and on the morning of the 3rd Cape San Francisco was in sight, 15 or 20 miles distant. At 6.08 a. m. a successful haul of the trawl was made in 741 fathoms. Tide rips were frequently encountered

as we approached the land, and birds, both land and sea, increased in numbers. Blackfish and porpoises were seen frequently, besides myriads of flying-fish. Squally weather incident to the region of doldrums was experienced after losing the SE. trades until those from NE. were picked up in 4° N.

Four hauls of the trawl were made on the 5th near the Pearl Islands in 62, 33, 33, and 18 fathoms, besides one with the oyster dredge. The results of the day's operations were very satisfactory to the naturalists, the grounds proving very rich in life, and many of the forms new to science. We anchored for the night at 7.30 p. m. between Galera and St. Elmo Islands, in 21 fathoms. Getting under way at 5.45 on the morning of March 6 we steamed to the eastward of the Pearl Islands, and at 11.15 cast the trawl in 30 fathoms, green mud, landing it on deck at 11.45, with a heavy load of mud, composed largely of decayed organic matter so offensive in odor that it was considered prudent to move on.

We anchored off Perico Island at 3.10 p. m. and received a visit from the commanding officer of the Colombian revenue-cutter *Boyaca*, who informed us that by virtue of a decree of the National Congress dated November 3, 1887, all vessels from Chilian ports were forbidden entrance to the harbors of the United States of Colombia, and that we must go immediately to the anchorage near Taboguillo Island. Having handed him cablegrams, letters, etc., which he promised to forward or deliver, we got under way and proceeded to the island, as directed, anchoring in 10 fathoms, about half a mile from shore.

We were left to ourselves until noon of the 8th, when Dr. Halstead, the quarantine officer, came alongside and made the usual inquiries, taking our bill of health, and a statement from the surgeon that we had been at sea seventeen days, during which time there had been no sickness on board. Our case was not one of quarantine, simply, but of absolute exclusion according to law, the governor being the only officer on the Isthmus with authority to modify it. I had already informed the United States consul-general, Capt. J. M. Dow, and Mr. Henry Schuber, of our arrival, and requested their good offices in procuring us pratique with as little delay as possible. The doctor brought us a large mail which had accumulated at Panama, also such mess stores as were ordered by the caterers. Promising to exert himself in our behalf, he left until the following day, when he informed us that the last official act of the retiring governor-general, Alejandro Posada, was to sign an order admitting the *Albatross* to pratique, on March 13, providing cholera did not break out on board in the mean time, and further, that we would not give the crew liberty to go on shore in Panama.

Nothing of moment occurred until the evening of the 13th, when the health officer visited the ship, and, having satisfied himself that no cases of cholera had occurred, gave us pratique. It was too late to move that evening, but we were under way early the following morning, and steamed to the Pacific Mail station off Naos Island, where Captain

Shackford, the company's superintendent, piloted us to a convenient berth. I went to Panama soon after we anchored, and called on the United States consul-general, Mr. Adamson; Captain Dow, general agent of the Pacific Mail Steam-ship Company; Mr. Henry Schuber, and others, and at 10 a. m. on the 17th, in company with Mr. Adamson, I called on the governor of Panama. The consul visited the ship on the 20th.

We hauled the *Albatross* out on the beach at the Pacific Mail Steam-ship Company's station on the morning of the 21st, and scraped and painted her bottom, returning to our berth the following morning. The U. S. S. *Omaha*, Capt. F. V. McNair, arrived from Yokohama on the 23d, and anchored in the outer roads. I paid my respects to the captain during the evening, the call being returned on the 26th.

We were subjected to vexatious delays in getting coal, owing to a scarcity of lighters; the first one came alongside on the 26th, and we finished on the 28th, having taken on board 205 $\frac{900}{2240}$ tons, for which we paid the Panama Railroad Company $17 per ton. The weather was dry during our stay in Panama, with the exception of a few light mist squalls. Northerly winds prevailed, although calms and light variable airs were of frequent occurrence. The temperature ranged from 75° to 88° Fahr. It was the last of the dry season, and heavy cumulus clouds could be seen gathering in the mountains daily, but the parched surface of that elevated region robbed them of their moisture before they reached the Pacific.

We were under many obligations to the officers of the Pacific Mail Steam-ship Company, the Panama Railroad Company, and Mr. Henry Schuber for their efforts to forward our work and to make our stay as pleasant as possible.

Panama to the Galapagos Islands.—We got under way at 10 a. m., on March 30, and half an hour later commenced a series of dredgings to seaward, making five hauls in from 7 to 51 fathoms, over an exceedingly rich bottom, from which we obtained great numbers of specimens. An unexpected depth of 1,927 fathoms was found the following morning in 6° 44′ N., 80° 27′ W. Porpoises, turtles, flying fish, and birds were constantly in sight, particularly about the numerous tide-rips through which we passed. For half an hour, between 2.30 and 3 p. m., we steamed through a blood-red sea, the margin of discoloration being well defined and extending in irregular lines as far as the eye could reach. This remarkable phenomenon had its origin in a dense mass of minute forms of algæ, *Trichodesmium*, in a larval state, floating from 1 to 3 feet below the surface. This conferva is usually mistaken for animal life by seamen, and, when seen under a microscope, where the minute particles will be observed darting about with great rapidity, it is a difficult matter for the uninitiated to realize that they are of vegetable origin. The surface-net was towed for fifteen minutes in the evening,

when our efforts were rewarded by a large number of specimens, among which were many rare or unknown forms.

A sounding at 4 a. m., April 1, gave 1,727 fathoms, green ooze, in 5° 16′ N., and 83° 09′ W. Blackfish and porpoises were seen frequently, and one of the latter was taken with a harpoon. While steaming quietly along in a perfectly smooth sea a momentary excitement was caused by the port propeller striking a log about 7 feet in length and 12 inches in diameter, the shock being felt fore and aft, but no harm was done. Another sounding was taken at 11.28 p. m. in 1,882 fathoms, latitude 4° 18′ N., latitude 85° 14′ W. A westerly current of over a knot an hour was felt while making the sounding.

Findlay's North Pacific Directory contains the following, on page 694:

RIVADENEYRA SHOAL.

Being on board the steamer *Peru* abreast of Puña, October 22, 1842, and hearing that there was a terrible yellow fever raging in Guayaquil, the steamer put back, and I (Mr. Rivadeneyra) was placed on board a small schooner going to Realejo. On the 28th, in the middle of the day, the sea calm, we had caught a large turtle, when I observed at a few fathoms off a slight swell on the sea. We took the boat and went to it, when we sounded and, to our astonishment, found only 16½ feet (French) of water. In the center of this spot was only 10 feet depth; we then found 14, 16, 27, 56 feet, and then no bottom.

By our very imperfect instruments we made it to be in latitude 4° 15′ N., longitude 85° 10′ W. of Greenwich, but this we considered very nearly correct as we hastened on to Realejo.

The existence of this bank has been in some degree confirmed by the inquiries of Captain Lapelin, in the French corvette *La Brilliante*, in 1852. He ascertained that several vessels had struck on it, but did not give any information as to the correctness of the position assigned. Captain Harvey, of H. B. M. S. *Havannah*, passed within 4 miles of the place, in July, 1857, without seeing anything of it.

If this shoal exists it is a serious menace to the mariner, particularly as its position is so doubtful. We can hardly ignore the evidence of its discoverer, as he took a series of soundings, yet it has been searched for by men-of-war of most of the great maritime nations, without discovering the slightest indication of shoal water. It must be observed, however, that they were not provided with deep-sea sounding apparatus, and could only note surface indications.

We sounded in 1,657 fathoms, brown ooze, at 1.55 a. m., April 2, latitude 4° 14′ N., longitude 85° 11′ W., near the position assigned to Rivadeneyra Shoal, 10 (10 feet), Hydrographic Office Chart No. 1007; and at 4 a. m., in 1,727 fathoms, gray ooze, latitude 4° 02′ N., longitude 85° 25′ 30″ W. Another cast at 4 p. m., in latitude 2° 53′ N., longitude 86° 24′ W., gave us a depth of 1,616 fathoms, gray ooze, largely globigerina. Turtles and surface fish were seen in diminished numbers, and another drift-log of considerable size was observed floating very low, nearly waterlogged.

The line was extended in the direction of Chatham Island on the 3d by two soundings, the first at 9 a. m., in 1,341 fathoms, globigerina

ooze, latitude 1° 13′ N., longitude 88° 02′ W., followed by a cast at 4.45 p. m., in 1,379 fathoms, ooze, latitude 0° 30′ N., longitude 88° 37′ 30″ W. A cast of the trawl resulted in a water haul, notwithstanding an unusual allowance of rope.

The line of the hydrographic soundings from Cape Mala to the Galapagos via the reported position of Rivadeneyra Shoal ended with the last cast, and demonstrated the non-existence of the danger in the position assigned it, or in the line of our soundings. The matter should not be considered as finally settled, however, for it may lie north or south of our route, and it is only by a line of soundings at right angles to those of the Albatross that it can be satisfactorily determined.

Chatham Island was sighted from the mast-head at daylight on the 4th of April, and at 5.31 a. m. we cast the trawl in 812 fathoms, globigerina ooze, latitude 0° 24′ S., longitude 89° 06′ W., and again at 9.07 in 636 fathoms, gray sand, latitude 0° 36′ 30″ S., longitude 89° 19′ W. A third haul was made at 2.20 p. m., in 45 fathoms, gray sand, latitude 0° 50′ S., longitude 89° 36′ W. They were all successful, although the net was badly torn, the second and third casts having come in contact with rocks or coral heads.

The Galapagos Islands.—Steaming along the west, or lee side of Chatham Island, we passed Kicker Rock, its vertical walls, 100 feet or more in height, giving it the appearance of a sail; in fact it was reported by the lookout as a square-rigged vessel. Dalrymple Rock is smaller, from 50 to 60 feet in height, and at a distance resembles a boat with lug sail. It lies about 2 miles from Lido Point, and is an unmistakable landmark.

At 3.20 p. m. we anchored in Wreck Bay, a safe and convenient harbor, near the southwest end of Chatham Island. This is the sea-port of the Hacienda del Progres, a plantation located on the highlands in the interior of the island, about 5 miles distant, and connected with the coast by a good wagon road. The bay is surrounded by low land covered with bushes and small trees, and a smooth steep sand beach affords convenient landing. The projecting points are composed of lava rock. There is a light-house near the beach, and a short distance south of it a store-house, which is also used as a keeper's dwelling, the landing-place being directly in front of it.

The land begins to rise a few hundred yards from the beach, and the ascent is constant until the hacienda is reached, at an elevation of about 900 feet above the level of the sea. The low lands of Chatham, in common with those of all the islands of the archipelago, is entirely without living water, and in the dry season presents a most barren and desolate appearance. All this is changed, however, during the rainy season, which usually begins about the 1st of April, and continues until the last of June. It began in February this year, and in consequence everything was fresh and green, the general aspect being decidedly tropical.

To enter Wreck Bay stand for Dalrymple Rock, and when up with it steer SSE. $\frac{3}{4}$ E. for the light-house. This consists of a spar 25 or 30 feet in height surrounded by an iron cage, which contains the lantern. Make due allowance for the current, and anchor in from $5\frac{1}{2}$ to 6 fathoms, when Malamocco Point will bear about SW. $\frac{3}{4}$ W. and the light-house SE. by S., magnetic.

We were visited about an hour after our arrival by Manuel A. Cobos, the son of Señor Manuel J. Cobos, one of the proprietors of the island. In his father's name, and in very good English, he tendered his services during our stay, and offered to send horses down to the beach for as many of us as wished to visit the hacienda. Proper acknowledgments were made, and the following morning Professor Lee, Mr. Townsend, Mr. McCormick, and I availed ourselves of his invitation, and went up to the settlement. Señor Cobos met us at the door of his residence, expressed great pleasure at our arrival, and entertained us in a most hospitable manner.

The settlement consisted of the residence of the proprietor, with the necessary store-houses, cane-mills, etc., and numerous simple native houses, sufficient for the accommodation of the inhabitants, who numbered about two hundred.

Fresh horses were brought to the door, and in company with Señor Cobos and son we rode over a portion of the estate, where we saw great fields of sugar-cane, sweet-potatoes, and other tropical and semi-tropical products growing side by side. A young coffee plantation gave promise of future profit, and oranges, lemons, and limes were growing in profusion. Large herds of cattle were seen feeding in excellent pastures, inclosed with iron fences, hedges, or the favorite broad, deep ditch, the proprietor estimating the number of cattle on the island at 20,000. Horses, mules, asses, sheep, and hogs were seen in large numbers, more than sufficient for all purposes of the plantation. Water was procured from a large spring and carried to the settlement by ditches which could be seen winding around the hills.

Guayaquil is their only market, and, as most of the products compete directly with those of Ecuador, it does not always prove a profitable one, only the higher priced articles bearing the cost of transportation. Rum, hides, orchilla, fish, and a little fruit are the principal exports.

Chatham Island, and in fact all the islands of the archipelago are of recent volcanic origin, the only arable land being in the elevated basins of the craters. Here, on the principal cone near the center of the island, we found the Hacienda del Progres.

Before our return to the ship, Señor Cobos proposed to send his son and a couple of his best native guides with us through the islands, as their local knowledge would save us much time and be the means of adding to our collections. His proposition was thankfully accepted, and they made the cruise through the archipelago with us, rendering valuable service both afloat and on shore.

Leaving Wreck Bay on the morning of the 7th, we steamed to Hood Island, anchoring at 10 a. m. in Gardner's Bay. The naturalists, with large parties of volunteers, spent the day on shore, and added many specimens to our collection. Birds, lizards, and hair seals were found on the island, while several species of fish were taken by parties on board. The anchorage was infested with small sharks, which were taken by the dozens until the fishermen tired of the sport.

Hood Island is low compared with others of the group, its surface being covered with masses of broken lava rock. A little soil has formed between the blocks, in which bushes of various kinds find root, and, during the season of rains, lend a rich green hue to the otherwise barren surface. It is wholly devoid of fresh water during the dry season, and has no commercial value. Gardner's Bay is a good anchorage in the fine weather that usually prevails, but is open to northerly and westerly winds.

At 5.08 p. m. we got under way and made two hauls with the dredge over a rough bottom, then one with the tangles, and finally the small beam-trawl was lowered, but came up a wreck. The submarine electric light was used for surface collecting during the evening. A sounding was made in 286 fathoms, fine gray sand, latitude 1° 23′ S., longitude 89° 58′ W.; another in 191 fathoms, latitude 1° 25′ S., longitude 90° 07′ W., and at 7.47 on the morning of the 8th we anchored in Black Beach Road in 11 fathoms, sand.

This anchorage is an open bay, but, being on the west (or lee) side of Charles Island, affords good shelter from the trades, which blow most of the year. It is the sea-port of what was at one time a flourishing settlement, now abandoned, and derives its name from a short stretch of black sand beach lying at the head of the bay, between low cliffs of dark lava rock. To make the anchorage, bring the sand beach to bear east (magnetic), having the highest peak visible on the island a little on the starboard bow, and stand in carefully, anchoring in from 10 to 11 fathoms. The bottom is very rocky outside of that depth, and has the reputation of being foul inside.

The settlement mentioned was a penal colony of Ecuador, established about 1830, and was in a flourishing condition until 1879, or near that time, when the convicts mutinied, murdered those in authority, and seizing the vessels in the harbor put to sea, landing, it is supposed, on the coast of their native country. Buildings, stock, etc., were left unmolested, and at the time of our visit great numbers of cattle, horses, mules, donkeys, sheep, and hogs were running wild. The buildings were falling to ruin, but there was a plentiful supply of fruit on the trees, from which we procured many bushels of oranges and limes, a pleasant addition to our monotonous fare. The distance from the landing to the first improvements was about 3 miles, over what had been a good wagon-road.

The naturalists, with numerous volunteers, were soon on shore, and,

following the native guides, spread over the accessible portions of the island, making collections. One party took the road to the interior, and arriving at the first watering-place, met, much to their astonishment, an almost naked man, a Robinson Crusoe in appearance. He was recognized by the guide as Pedro Guaza, one of a party of orchilla-pickers from Chatham Island that had been there over a year ago, and who, when about to return, could not be found. He claimed that he had lost his way, and had searched in vain for the station until long after the party left, but after questioning him I had no doubt of his intention to remain behind. He was doubtless fascinated by the sight of flocks and herds roaming over the island, waiting only for man to reclaim them, and desired to be the possessor of all this wealth. He had lost the run of time, and one of his first questions was, "What month is it?"

His methods of getting animal food were simple and effective. He constructed a blind near where the animals were obliged to pass to the watering place, and with his large knife lashed to a pole he speared the hogs and sheep; a lasso properly disposed was equally effective for the capture of bullocks. A donkey or two taken in the same manner served for transporting fuel, he having obtained fire by the well-known process of rubbing together two sticks. It was evident that he had enjoyed his solitary honors long enough, and was glad to find himself again among men, even to return to bondage on Chatham Island.

The naturalists made large collections on Charles Island, being able to reach the high lands in the interior by the old wagon-road. Several flamingoes were shot in a lagoon about 2 miles from Post-Office Bay.

Leaving Charles Island on the evening of the 9th, we made three hauls of the dredge and tangles near the anchorage, then steamed for Albemarle Island, anchoring in Iguana Cove at 9.10 the following morning. We intended spending the day in exploring the southern portions of the island, but the surf was rolling in so heavily that landing was impracticable. We were disappointed, for great things had been expected of this locality. Getting under way we steamed to the northward for Tagus Cove, on Albemarle, opposite Narborough Island, where we were more sure of a good harbor and convenient landings.

Albemarle Island is by far the largest of the Archipelago, but is uninhabited, and has no present commercial value except for its orchilla, which grows on bushes and trees and has slight resemblance to Florida moss. It is used for making purple dye, and commands a high price in the European markets. The highest point on the island is within 3 or 4 miles of the southern extremity, and reaches an elevation of 4,700 feet. A rich green foliage covered the rugged surface of huge lava bowlders to the very summit. Further to the northward and all along the west coast as far as Tagus Cove the land was comparatively low and presented a striking resemblance to a burnt district, dotted with numerous small volcanic cones. The general aspect was a reddish brown, but it

was varied by occasional pyramids, symmetrical in form, and of lighter color, resembling artificial mounds of sand and mud which had had barely time to dry. The line of demarkation between the rich carpet of foliage and utter desolation of the barren district was so regular and well-defined that it was difficult to realize that it was nature's handiwork.

Narborough Island presented in the distance an unbroken covering of rich green foliage to the very summit of its central peak, 3,720 feet above the sea, and, on nearer approach, a fringe of luxuriant mangroves bordering the eastern shore, and the margin of a small bay, or lagoon, added fresh charm to the view. As we steamed through the narrows between Narborough and Albemarle Islands the contrast of a rich and abundant vegetation on the one hand, and utter barrenness and desolation on the other, was very striking. We anchored in Tagus Cove at 4.45 p. m. and found it a perfect harbor, with swinging room for the largest vessel, although the high land surrounding the bay dwarfed it at first view.

The naturalists and volunteers scattered over the land and along the shores as soon as the anchor was down, and returned at dark, well satisfied with the results of collecting. The watering place marked on the chart was perfectly dry, and we learned from Mr. Cobos that it was only during the latter part of the rainy season that water could be found. There were patches of green near the northern end of Albemarle Island, but the general aspect was barren and desolate. As the sun went down we were beset by myriads of mosquitoes, bent upon making the most of a rare opportunity. Their attack was so vigorous that at 9.25 p. m. we got under way and steamed out to sea, en route for James Bay.

The weather was partly overcast when we left our anchorage, but we thought little of it, supposing it to be one of the short passing squalls so frequent during the rainy season. When we reached the vicinity of Cape Berkeley, however, the rain poured down in torrents for several hours, and it became so thick that we were obliged to stop the engines until the weight of it passed, when we continued our course, anchoring in James Bay at 1.30 p. m. in 6 fathoms, white sand.

The naturalists with their corps of volunteers were off as usual as soon as the anchor was down, returning at sunset with many additions to their collections. Several flamingoes were shot in a small lagoon back of the beach, and a variety of fish were taken with hand lines from the ship. Among them were many bacallão (cod-fish), so called by the inhabitants of Chatham Island, who take them in large numbers for their own consumption as well as for the Guayaquil market, where they bring a good price. It is a species of grouper from 6 to 30 pounds in weight, and takes the hook readily. We found it an excellent fish when fresh, and it is said to resemble cod-fish in texture and flavor when cured in the same manner.

James Bay is on the west end of James Island, which protects it from

the prevailing winds, the swell being partially broken by projecting points and small islands. It is a good anchorage with easterly winds, and may be recognized by the following landmarks. Albany Island is conspicuous, being lighter in color than its surroundings, and abreast of it are bold lava cliffs which extend to a short stretch of white sand beach at the bottom of the bay. The southern extremity is marked by a point having a double peak from which extends a barren lava-covered belt, resembling that described on Albemarle Island. Small salt lagoons lie just back of the sand beach. To make the anchorage it is only necessary to stand in for the center of the white sand beach, anchoring in any depth desired. The watering place mentioned is on a point nearly abreast of Albany Island, and, during the latter part of the rainy season, furnishes a good supply, but at other times the flow is either very small, or fails altogether. The supply is so limited and uncertain that the orchilla pickers who visit the island periodically do not depend upon it. The general aspect north and east of the bay was fresh and green, and a fringe of mangroves surrounding the lagoons gave that portion of the bay a particularly attractive appearance, while to the southward was a barren waste.

We left James Bay on the morning of the 12th, and, after a run of about six hours, anchored in Conway Bay in 6 fathoms, white sand and stones. Several parties of collectors left the ship, and volunteer fishermen soon had lines over the rail, where several species of fish were taken.

Indefatigable Island is circular in form and about 20 miles in diameter, with a central cone, in the basin of which lies a vast tract of arable, well watered land, capable of growing all the tropical and semi-tropical products in great perfection. Its natural resources are greater than any other island in the group, yet it is uninhabited and wholly undeveloped. The low lands are devoid of water, and, like the other islands, barren and desolate during the dry season, the rain only bringing life to the bushes and stunted trees, which find a precarious existence among the lava bowlders and scoria. To render the fertile lands of the central elevated region available it would be necessary to construct a road 6 or 8 miles in length to connect it with the sea.

Conway Bay lies on the west end of the island and is easily recognized by the Guy Fawkes Islands to the northward and Eden Island to the southward. It is protected from the prevailing winds, and, in that region of almost universally fine weather, it is a good anchorage.

We were under way at 5.30 on the morning of the 13th and at 6.55 anchored in 15 fathoms, sand and stones, in an open bay on the northeast side of Duncan Island. We were off a conspicuous gorge in the mountain side, and about 200 yards to the southward of a small islet which lay directly in front of it, and about 50 yards from the shore. Its surface was covered with bushes and other vegetation, which distinguishes it from rocks further to the southward. There was an excellent landing place for boats inside of the islet.

The general appearance of Duncan Island was green, bushes and

cactus being distributed over its surface. There is no living water on the island, yet it is a favorite resort for the celebrated galapagos, from which the group derives its name. A hunting party, consisting of our guides and several of the crew, were dispatched to the mountains for tortoises, while the naturalists gave their attention to birds, lizards, fishes, etc. Ten galapagos of moderate size were secured, the guides bringing two each down the rugged mountain side.

We left our anchorage at 4.40 p. m., cast the lead in 108 fathoms 4 miles S. ½ W. of Barrington Island, and in 139 and 329 fathoms between the latter and Chatham Island, where we arrived and anchored at 6.55 a. m. April 14. Young Mr. Cobos and the native guides left us during the morning, the latter having been compensated for their services, and acknowledgments made to the former for his advice and assistance. Supplies were received from the plantation during the day, and preparations made to leave the islands. Señor Cobos visited the ship during the afternoon, and in the evening we received from him eight tortoises, one very large one, a quantity of fruit, and a fine bullock. While on board he informed me of the existence of a rock not shown on the chart of Wreck Bay, lying about 3 cables SSE. magnetic from Lido Point, having 15 feet on it at low water. It undoubtedly exists in about that position, but I had no opportunity of verifying it.

At 7.50 a. m. April 15 we left the island, made three successful and very interesting hauls of the trawl during the day, and, at 7.20 the following morning, anchored in 20 fathoms off the south end of Abingdon Island, about midway between Capes Chalmers and Ibbetson. We had just swinging room, and, although entirely exposed, the swell was not heavy, and landing was effected with but little trouble. The collectors went on shore, returning at 10 a. m. thoroughly satisfied with their experience of the island, which they declared was the hottest place they had seen during the voyage. The collection of birds, lizards, etc., was increased by numbers of fine specimens. Among the fishes was a beautiful golden grouper, the only one taken, although they were seen in the water on several occasions.

Galapagos Islands to Acapulco and La Paz, Mexico.—We were under way again at 10.37 a. m., en route for Acapulco. The winds were light and variable with passing rain squalls and frequent lightning, and several water-spouts were seen during the afternoon.

At 5 p. m. we made Wenman Island, about 25 miles distant, and next to Culpepper, the most northern of the archipelago.

The 17th was calm most of the time, hot and sultry, with frequent lightning to the northward. At 8 p. m. we sounded in 1,976 fathoms, brown ooze, latitude 4° 44′ N., longitude 93° 02′ W. The trades were encountered on the 18th, in 6° N., light at first, but gradually increasing to a moderate breeze with clearing weather. The equatorial counter current was felt between latitudes 3° and 6° N., setting 13 miles N. 32° E., in twenty-four hours, it having been 30 miles N. 32° W. the previous day, and 46 miles S. 81° W. the day following. The first indication of

a weather set was a confused swell which could not be accounted for by the prevailing winds.

At 8.05 on the morning of the 19th, a sounding was made in 1,997 fathoms, green mud, latitude 8° 26′ N., longitude 95° 30′ W. We were surprised by the announcement from the laboratory that, after a careful microscopical examination, they failed to find more than a trace of foraminifera in the bottom specimens, and that it was without doubt of continental origin. Another sounding was made in 2,256 fathoms, green mud, at meridian on the 20th, in latitude 11° 45′ N., longitude 97° 03′ W. Tropic birds and boobies were seen every day, also flying fish and turtles, which constituted about all the life seen between the islands and the Mexican coast. The last sounding of the series was made at 1 p. m., on the 21st, in 1,862 fathoms, green mud, latitude 14° 33′ N., longitude 98° 14′ W., and at 11.25 on the morning of the 22d we anchored in the harbor of Acapulco.

The United States consul visited the ship during the afternoon, and on the following day Prof. L. A. Lee and I returned his call. Accompanied by him we paid official visits to the military commandant and captain of the port, and later in the day I called on the commander of the Mexican gun-boat *Democrata*. We commenced coaling on the 23d and finished at 7 p. m. the following day, having taken on board 122 tons. It was a good quality of Cardiff coal, delivered in lighters at the wharf for $14 per ton.

We got under way as soon as the coal was on board, and left the harbor at 7.30 p. m. for La Paz. The weather was clear and warm with light, variable winds and smooth sea. Nothing occurred worthy of mention until on the 26th at 1.40 p. m., we cast the trawl in 294 fathoms, blue mud, latitude 18° 43′ N., longitude 104° 04′ W. A large number of a scaleless *Macrurus*, unknown to us, were found in the net, but, to our surprise, nothing else. Another haul was made at 4 p. m. in 117 fathoms, blue mud, latitude 18° 52′ N., longitude 104° 10′ 30″ W., in which large numbers of small red shrimp were taken, besides five species of fish and an octopus. The bottom was composed largely of decomposed vegetable matter, which emitted an offensive odor.

Resuming our course after the haul was finished, we had a quiet and uneventful run to Pichilinque Harbor, Bay of La Paz, where we anchored at 1.20 p. m., April 29. A boat was sent to town to communicate with the United States consul and to get a mail which we were informed had been sent there. A market boat was sent in at daylight the following morning, and on its return at 9.30 we got under way and made two hauls of the trawl in the bay, two hauls of the tangles and dredge in San Lorenzo Channel, and finally three hauls of the oyster dredge off the west side of Ceralbo Island, abreast of Point Gorda. They were all successful, some of them being particularly rich.

La Paz, Mexico, to San Francisco, California.—We were off San José del Cabo at daylight on the morning of May 1, and half an hour later swung ship under steam for compass errors. At 8.18 the tangles were

lowered in 31 fathoms, rocky bottom, near the Frailes, Cape San Lucas, and a variety of interesting specimens were secured, although it was not so rich as we anticipated. A strong current to the southward and eastward was felt as we rounded the cape, but we lost it later in the day. At 6 p. m., a successful haul of the trawl was made in 66 fathoms, fine sand, latitude 23° 33′ N., longitude 110° 37′ W. We began to feel the coast winds from NW. during the day, light at first, but increasing to a moderate breeze with a decided fall in temperature.

Passing Cape Tosca at daylight on the 2d we entered Magdalena Bay, and at 7.35 anchored in 7 fathoms near the NW. extremity of Sta. Margarita Island, and one-fourth of a mile from shore. The naturalists with parties of volunteers landed as soon as we anchored and returned at meridian, having met with fair success. We got under way immediately after their return and made a haul of the trawl near the anchorage; then steamed out of the bay, passing Entrada Point at 1.18 p. m. A haul of the trawl, and another with the tangles was made between 3 and 4 p. m., and an hour later we passed Cape San Lazero and laid a course for Abreojos Point.

Pleasant weather continued, with increasing winds from the westward. High land was sighted at daylight on the 3d, and at 7.30 a. m. the trawl was cast in 48 fathoms, sand and mud, latitude 26° 14′ N., longitude 113° 13′ W. Large numbers of whales were seen during the forenoon while we were passing Ballenas Bay. Abreojos was made at 11 a. m., and at 12.30 p. m. we anchored in 5 fathoms under the lee of the point.

The surf was quite heavy, but we landed the collectors without much difficulty, and they returned at night fairly well satisfied with the day's collecting. Being anxious to obtain specimens of the coyote for the National Museum, Mr. Townsend placed several pieces of poisoned bait on the beach, and, on visiting the locality the following morning, found three fine specimens lying dead.

Getting under way at 7.30 a. m., we made a haul of the dredge in 5 fathoms, followed by the tangles in 6 fathoms, in the vain endeavor to procure living specimens of mollusca. Great windrows of their dead shells were thrown upon the beach, but were perhaps from deeper water. Standing out clear of the shoals we steamed up the coast, passing Asuncion Island at 4 p. m., San Roque Point at 5.30, and Morro Hermoso at 9.10 p. m. Whales were seen frequently during the day.

May 5 opened with moderate westerly winds and frequent mist squalls, which saturated everything about decks, and was so thick at times that we were unable to see the ship's length, but it cleared at daylight, and at 6.20 we anchored in a small bay to the northward of Morro Redondo, Cerros Island.

The collectors were landed, returning on board at 9 a. m., when we got under way and steamed along the east side of the island, finally anchoring at 10.30 about 9 miles from Morro Redondo, off quite an extensive valley, and in sight of the cedars on the heights, from which the island derives its name. The collectors were again landed, and re-

turned at 4 p. m. with birds, lizards, etc., and two wild goats. Three deer were seen, and the skeleton of a horse which had died, probably from lack of water. The following legend was found on a head-board over a grave near the beach: "To the memory of John Andrews, ship *Latonia*, 1819," with other information that was not deciphered.

Getting under way at 4.15 a haul of the dredge was made in 23 fathoms, mud, and standing off shore about 2 miles, the trawl was lowered in 44 fathoms, a few interesting specimens being taken. Arriving off the north end of the island at 6.30 p. m. the Benitos were in sight on the port hand, and Lagoon Head to starboard, a view possible only in very clear weather.

We passed San Martin Island at 2.25 p. m. on the 6th, Cape Colnett at 6.15, the Coronados on the morning of the 7th, and at 5 p. m. we anchored outside of the kelp in Smuggler's Cove, San Clemente Island. The surf was too heavy to land that night, but at daylight next morning a party got on shore from the boat, landing at the SE. extremity of the island, and returned at 8.30, when we steamed along inside of the island until 11.05, and anchored off a sheep corral near the NW. extremity. The collectors landed as usual and returned at 2.40 p. m., well satisfied with their few hours' work. The island is occupied as a sheep ranch, and although it is entirely without water during the dry season the large flocks seemed to be thriving.

We left the island at 2.40, and at 4 made a successful haul of the trawl in 414 fathoms, gray sand. Passed Santa Barbara Island at 9.50, the Santa Cruz channel between 3 and 4 a. m., on the 9th, and at 8.30 made a successful haul of the trawl in 276 fathoms, green mud.

We passed Point Conception at 12.30, and Point Arguello at 2.30 p. m., and at the close of the day were steaming up the coast against a brisk breeze and moderate head sea. Piedras Blancas was passed at 2.35 a. m. on the 10th, Point Sur at meridian, Point Pinos at 3.50 p. m., and at 10.22 p. m. made Pigeon Point Light. We were steaming against a strong head wind and heavy sea throughout the day.

May 11 commenced with misty weather about the horizon, obscuring the land at times. At 7 a. m. we entered the Golden Gate, and at 8.10 anchored off the foot of Washington street, San Francisco, Cal.

The officers and crew were in good health, and the ship was in fine condition considering the long voyage just completed. Some small repairs were needed on boilers, machinery, and boats, but had it been necessary we could have turned the vessel's head homeward and steamed to the Atlantic without a dollar's expense for repairs.

San Francisco.—We were visited by the quarantine officer and granted pratique without delay. The United States revenue officers visited us also, and were evidently at fault as to our status. They were shown through the laboratory and other parts of the ship, and finally left, still puzzled, but apparently satisfied regarding our honest intentions, as we heard nothing more from them. Mr. Jos. D. Redding, Mr. C. Josselyn, and Mr. J. K. Orr visited the ship soon after our arrival, and Governor

Waterman made a long call the following morning. Much interest was manifested in the vessel and her work, and we were the recipients of much kindly attention during our stay in San Francisco. Necessary repairs were promptly made by the Union Iron Works.

The terms of service of a large portion of the crew having expired they were discharged. A few reshipped, and vacancies were filled by new men. Seamen's wages on the Pacific coast were so much higher than the Navy pay that we found it difficult to get good men.

On the 19th of June we made a series of observations to determine the specific gravity of the water in San Francisco Bay, in order to ascertain whether it would be practicable to plant the lobsters, which were en route for the Pacific, anywhere within its limits.

Specific gravity of the water of San Francisco Bay, reduced to 60° Fahrenheit.

	Surface.	Bottom.
One-quarter of a mile west of Yerba Buena Island	1.019887	1.021487
One-quarter of a mile WSW. of Saucelito Wharf	1.019887	1.021487
One-eighth of a mile off Yellow Bluff	1.018687	1.021637
One-quarter of a mile S. by W. of Alcatray Island	1.019887	1.021487

The average specific gravity of sea water being 1.0274, it became evident that, all impurities aside, the salinity of the water would not warrant the planting of lobsters in the bay, with any probability of success.

The vessel was docked, her bottom cleaned and painted on the 26th and 27th of June. We coaled ship on the 30th, and, being at a wharf, took advantage of the opportunity to discharge a large number of specimens. We dropped into the stream before dark, practically ready for our Alaskan trip.

An itinerary was prepared before we left Washington, in which an estimate was given of the time required to make the voyage, the distance, average speed, amount of coal consumed, average cost, etc. The following table, showing the estimated and actual distances, etc., will be of interest as an evidence of the accuracy with which such matters can be calculated with a modern steam-vessel over known routes.

	Time actually en route.		Total distance.	Average speed per hour.	Coal.			
					Bought.	In bunker on arrival.	Total cost.	Average cost per ton.
	Days.	*Hours.*	*Miles.*	*Miles.*	*Tons.*	*Tons.*		
Estimated	88	0	15,830	7.8	1,066	30	$10,573.80	$9.92
Actual	85	5	15,956.7	7.793	1,061.75	30	9,710.53	9.022

A list of anchorages and summary of meteorological observations are appended, and will be found of interest. The engineer's report contains an account of operations in his department. The dredging and trawling record, the record of hydrographic soundings, and the record of specific gravities are appended. With reference to the latter,

it is probably the most systematic and accurate series of observations ever taken over the same regions.

The following officers were attached to the ship on the 30th of June, 1888:

Z. L. Tanner, lieutenant-commander, U. S. Navy, commanding.
H. S. Waring, lieutenant, U. S. Navy, executive officer and navigator.
Marbury Johnston, ensign, U. S. Navy.
Henry E. Parmenter, ensign, U. S. Navy.
Edward W. Eberle, ensign, U. S. Navy.
C. M. McCormick, ensign, U. S. Navy.
James E. Gardner, passed assistant surgeon, U. S. Navy.
C. S. Williams, assistant paymaster, U. S. Navy.
C. R. Roelker, passed assistant engineer, U. S. Navy.

Prof. Leslie A. Lee was attached to the vessel as assistant in charge of the scientific staff, with the following-named gentlemen as assistants: Charles H. Townsend, assistant naturalist; A. B. Alexander, fishery expert; Louis de F. Bartlett, captain's clerk.

Petty officers.—W. L. Watson, Walter Blundell, John Davidson, P. J. Owens, machinists; Charles Wright, master-at-arms; Samuel Le R. Pritchard, equipment yeoman; N. B. Miller, apothecary; A. F. Perkins, paymaster's yeoman; F. L. Stailey, engineer's yeoman. The crew numbered fifty-five men.

Number and name of anchorages on the trip from Norfolk to San Francisco.

No.	Place.	No.	Place.
1	Fortress Monroe, Virginia.	25	Black Beach Road, Charles Island, Galapagos Archipelago.
2	Port Castries, Sta. Lucia, West Indies.	26	Iguana Cove, Albemarle Island, Galapagos Archipelago.
3	Bahia, Brazil.	27	Tagus Cove, Albemarle Island, Galapagos Archipelago.
4	Abrolhos Islands.	28	James Bay, James Island, Galapagos Archipelago.
5	Montevideo, Uruguay.	29	Conway Bay, Indefatigable Island, Galapagos Archipelago.
6	Dungeness Point, Straits of Magellan.	30	North side Duncan Island, Galapagos Archipelago.
7	Gregory Bay, Straits of Magellan.	31	Wreck Bay, Chatham Island, Galapagos Archipelago.
8	Elizabeth Island, Straits of Magellan.	32	Southwest side Abingdon Island, Galapagos Archipelago.
9	Laredo Bay, Straits of Magellan.	33	Acapulco, Mexico.
10	Sandy Point, Straits of Magellan.	34	Pichilinque Harbor, La Paz Bay, Lower California.
11	Borja Bay, Straits of Magellan.	35	Magdalena Bay, Lower California.
12	Port Churruca, Straits of Magellan.	36	Abreojos Point, Lower California.
13	Otter Bay, Western Patagonia.	37	Cerros Island, Morro Redondo.
14	Mayne Harbor, Western Patagonia.	38	Cerros Island, northwest side of.
15	Latitude Cove, Western Patagonia.	39	Smuggler's Cove, San Clemente Island.
16	Port Grappler, Western Patagonia.	40	Northeast end San Clemente Island.
17	Island Harbor, Western Patagonia.	41	Northwest end San Clemente Island.
18	Port Otway, Western Patagonia.	42	San Francisco, California.
19	Lota, Chili.		
20	Tomé, Chili.		
21	Taboguilla Island, Bay of Panama.		
22	Panama, United States of Colombia.		
23	Wreck Bay, Chatham Island, Galapagos Archipelago.		
24	Gardner Bay, Hood Island, Galapagos Archipelago.		

Meteorological summary.

Locality and date.	Winds—hours.					Temperature.			Barometer.			Aggregate current.	Rain days.
	Southerly.	Northerly.	Easterly.	Westerly.	Calm.	Mean.	Maximum.	Minimum.	Mean.	Maximum.	Minimum.		
						°	°	°	°	°	°		
Montevideo to Cape Virgins, Jan. 12–17.*	47	95	....	....	8	65.5	83	48	29.93	30.14	29.72	N. 22° E. 20′.....	2
Cape Virgins to Sandy Point, Jan. 18–31.*	146	156	....	....	34	53.5	68	39	29.83	30.36	29.30	Magellan Straits	11
Sandy Point to Port Otway, Feb. 1–10.*	74	137	....	....	29	56	68	44	29.88	30.30	29.46	....do	7
Port Otway to Lota, Chili, Feb. 11–18.*	139	12	....	....	41	65	75	55	30.02	30.24	29.80	N. 76° W. 9″	0
Lota, Chili to Panama, United States of Colombia, Feb. 19–Mar. 6.*	241	124	....	....	43	72.5	85	60	29.90	30.08	29.72	S. 81° W. 69″....	7
Panama, United States of Colombia, Mar. 7–29.	23	451	13	35	28	81	88	74	29.84	30.00	29.68	None	3
Panama, United States of Colombia, to Wreck Bay, Chatham Island, Galapagos Archipelago, Mar. 30–Apr. 14.	112	97	105	12	57	83	90	76	29.80	29.94	29.66	S. 74° W. 145 m..	8
Wreck Bay, Chatham Island, Galapagos Archipelago, to Acapulco, Mexico, Apr. 15–23.	28	90	15	50	34	83	87	79	29.78	29.88	29.68	N. 61° W. 116 m.	1
Acapulco, Mexico, to La Paz, Lower California, Apr. 24–29.	24	55	0	44	20	79.5	88	71	29.83	29.94	29.72	N. 78° W. 19 m..	0
La Paz, Lower California, to San Francisco, California, Apr. 30–May 11.	23	6	3	240	12	65.5	80	51	30.06	30.22	29.90	N. 75° E. 40 m...	1

* Inclusive.

REPORT OF THE ENGINEER'S DEPARTMENT (ABSTRACT).

[From January 1 to October 24, 1887, by PASSED ASSISTANT ENGINEER G. W. BAIRD, U. S. Navy.]

Up to the 24th of October, the date of my detachment from the *Albatross*, the ship had steamed 1,745.9 knots on her course, in addition to the distance made while dredging and sounding. The vessel has not been detained in port through any fault of the machinery; the casualties have been few; the working of the machinery has been good.

Synopsis of the Steam Log to October 23.

Mean point of cutting off steam in the high pressure cylinders, from commencement of stroke ....inches..	16.1
Mean point of cutting off steam in the low pressure cylinders, from the commencement of stroke ....inches..	17.6
Mean number of holes (one-eighth) of throttle-valve open................	4.5
Mean vacuum in the condenser ....inches..	23.16
Mean pressure in boilers, per square inch ....pounds..	60.6
Mean pressure in receivers, per square inch above zero.............do....	20.2

Temperature:	
Of the engine-room ... deg. Fah.	110.3
Of the external atmosphere on deck ... do.	62.5
Of injection (sea) water ... do.	66.8
Of discharge water from condenser ... do.	93.6
Of feed water ... do.	81.8
Total time the fires were lighted ... hours.	3,793$\frac{4}{5}$
Total time engines were in operation, ship being on her course ... hours.	186$\frac{14}{15}$
Revolutions:	
Total number of starboard engine ...	815,047
Total number of port engine ...	821,172
Mean number per minute of starboard engine ...	72.58
Mean number per minute of port engine ...	73.21
Total nautical miles steamed ...	1,745.9
Mean nautical miles steamed per hour ...	9.33
Total tons of coal consumed ...	333$\frac{2167}{2240}$
Total tons of refuse ...	56$\frac{1236}{2240}$
Total tons of coal consumed while the engines were in operation ...	112$\frac{1003}{2240}$
Mean number of pounds of coal consumed per hour while the engines were in operation ...	1,347

With the new boilers the speed of the ship, as well as the economic performance of the machinery, has been greatly improved. Following is a comparison of the best runs of the ship with each.

	With the original boilers.	With the new boilers.
Date ...	Sept. 23, 1883	Sept. 15, 1887
Hours and minutes ...	10.48	8.30
Mean speed ...	10.44	10.93
Steam pressure ...	56.1	65.33
Receiver pressure ...	21.1	17.
Revolutions ...	78.65	79.91
Vacuum ...	24.04	21.5
Throttle ...	4.	4.6
Cut-off H. P ... inches.	19.	13.1
Cut-off L. P ... do.	18.5	17.3
Temperature:		
Engine-room ... deg. F.	103.7	117.
On deck ... do.	68.4	72.8
Injection ... do.	56.7	72.
Discharge ... do.	97.9	104.8
Feed-water ... do.	64.3	78.6
Mean draught of water ... feet and inches.	11.8$\frac{1}{4}$	12.7
Displacement in tons at above draught ...	978.	1142.
Indicated horse-power developed by the engines ...	442.	472.8
Indicated horse-power developed by circulating-pump ...	5.	5.
Aggregate indicated horse-power ...	447.	477.8
Pounds of coal consumed per hour ...	1406.	1177.
Pounds of coal per indicated horse-power per hour ...	3.14	2.31

The new boilers have not yet been urged, and the rate of combustion can be increased about 50 per cent. over that recorded above.

The usual periodical inspections have been made of valves, pistons,

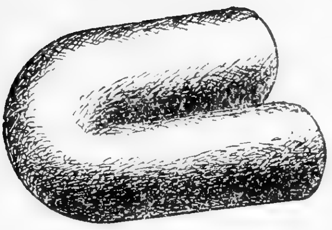


Fig. 1.

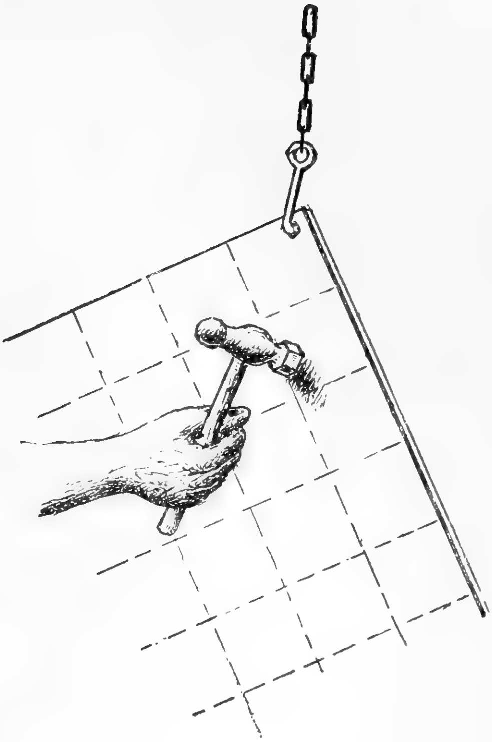


Fig. 2.

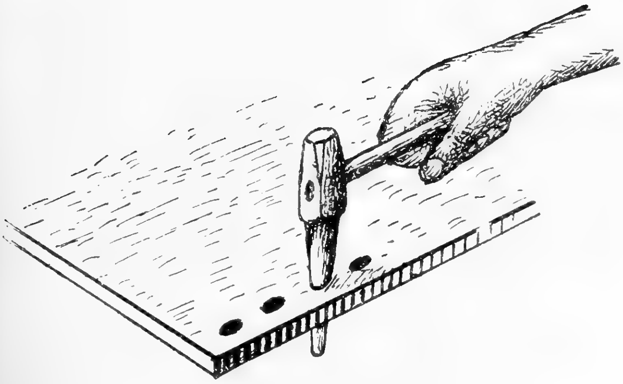


Fig. 3.

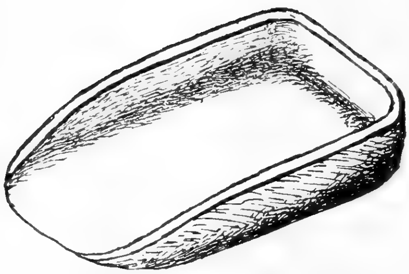


Fig. 4.

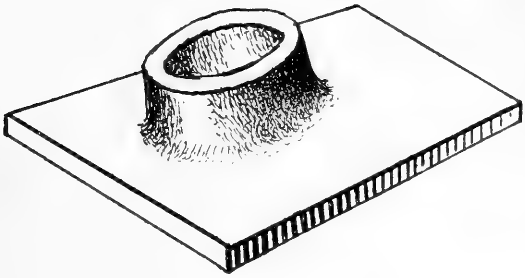


Fig. 5.

FIGURES ILLUSTRATING THE MANNER OF TESTING THE IRON FOR THE NEW BOILERS.
(See page 47.)

journals, etc. Liners were placed under low-pressure eccentric rods to restore lead of valves, which had become slightly worn, and repairs were made to the starboard low-pressure brasses.

The ship was docked at Baltimore August 19, after having been in the water continuously thirteen months and five days. One rivet in the forward end of the starboard bilge-keel was found to be loose. This was the first loose rivet, and the first leak discovered in the hull of the ship. All outboard valves were in good condition. The stern bearings were badly worn, but the shafts were clean and bright under the Edison insulator taps which had been put on to prevent corrosion. The Katzenstein packing placed on the valve stems has been beneficial. An expansion joint has been put in main steam-pipe between the engines. The Svedberg governors have had to be shifted, as by the new arrangement of bunkers they would have been in the coal storage. They are now more convenient for use than before, but they are also more in the way. I have converted the regurgitating valves of the feed-pumps into safety feed-valves, and have so piped the pumps that each will feed either boiler. The pneumatic indicators have answered their purpose well, and the Navy Department has again followed the lead of the Commission (as it did in the case of electric lighting) in placing this instrument in the new cruisers.

The contract for new boilers was signed by the president of the Columbian Iron Works, January 10, 1887, and by the Fish Commissioner, Professor Baird, on the 27th of the same month. The contract time was one hundred and twenty working days, a forfeit of $10 to be paid by the contractors for each day in excess of that limit required for completing the boilers. The writer was designated as superintending engineer of the construction, representing the Fish Commission, and the designs, specifications, and contract were drawn by him.

The iron for the new boilers was ordered by the Columbian Iron Works from the Christiana Rolling Mills, of Wilmington, Delaware. That mill had never made charcoal iron before, but they bought charcoal blooms of the best character, from which to roll the iron for the boilers. To prevent delay, I secured test pieces of the plates at the mill and tested them on a Fairbanks machine in Philadelphia, telegraphing orders to the mill whether the plates were to be accepted or not, thereby saving the expense of shipping condemned plates. For one cause and another it was necessary to condemn a large amount of iron, 26,000 pounds of shell plates being rejected in a single day.

The manner of testing the materials is represented in the accompanying figures: Figure 1 shows the bending test of a brace; figure 2, the hammer test of a plate; figure 3, the punching test; figures 4 and 5, the flanging tests; figure 6, the bending test for plates; figure 7, the bending of a rivet and the flattening of its head. These tests were made in the boiler-shop after the delivery of the iron. In the grooved specimens, some of the shell plates stood 59,000 pounds per square inch with

a reduction of area of 26 per cent. in the grooved specimens, and 56,000 pounds in the long specimens, with 35,000 pounds elastic limit, and 26 per cent. reduction of area. It is rarely that three-fourths-inch iron plates reach such high figures. Some of the flange iron (heads, furnace flues, etc.) failed in the shop; specimens from plates substituted were tested on the machine belonging to the supervising inspector at Baltimore. The contractors having failed to press satisfactory hemispherical braces for the back connections, asked the privilege and were allowed to make them of "low steel" (in reality ingot iron). Specimens from these showed 57,142 pounds per square inch, with 66 per cent. reduction of area. I was careful to see that they were annealed. The formers on which they were made were borrowed from the chief engineer of the Washington navy-yard.

The first main boiler was put on board August 5, and the second the 11th of the same month. As soon as they were closed steam was raised in the donkey-boiler and turned into the main boilers for the purpose of drying the kaolin which they were putting on. Thus the drying was kept up day and night. I utilized our own crew, doing whatever work it could, whether the items were included in the contract or not, in order to complete the arrangements and get the ship ready for sea. As the mechanics in the yard were vigorous patrons of the Knights of Labor, I was in constant fear that they would strike, on account of the amount of their work which our enlisted men were doing. In urging our work in the yard as well as on board ship, my own position became very much like that of a foreman in that ship-yard. The last delay was in getting the iron to lengthen the smoke-pipe. The pipe was erected September 6, the ventilators were put in on the 7th, and we raised steam on the 8th, at the earliest moment. The captain had declared his intention to sail as soon as we could run the engines. The last connection was made on the 14th, and the same day we raised steam and turned the engines over. At 10 o'clock that night the boiler-room gratings and ladders were temporarily in place, and although the boiler-room had not been painted, we went to sea at daylight on the following morning.

Instead of making the customary trial trip, the ship sailed directly to the deep water on the inner edge of the Gulf Stream, and began her regular fishery investigations, including dredging. On arriving at Wood's Holl I reported certain leaks in the boilers to the contractors, and boiler-makers were sent to calk them. The boilers were then accepted, but seventy-five working days over and above the contract limit had been required to complete them.

The total weight, as well as the potential and economic performance of the boilers, came within a small percentage of the results of my original calculations. The new boilers and bunkers are all contained within the bulkheads which inclosed the original ones, but there is now room for four days' additional coal, and 25 per cent. more maximum power.

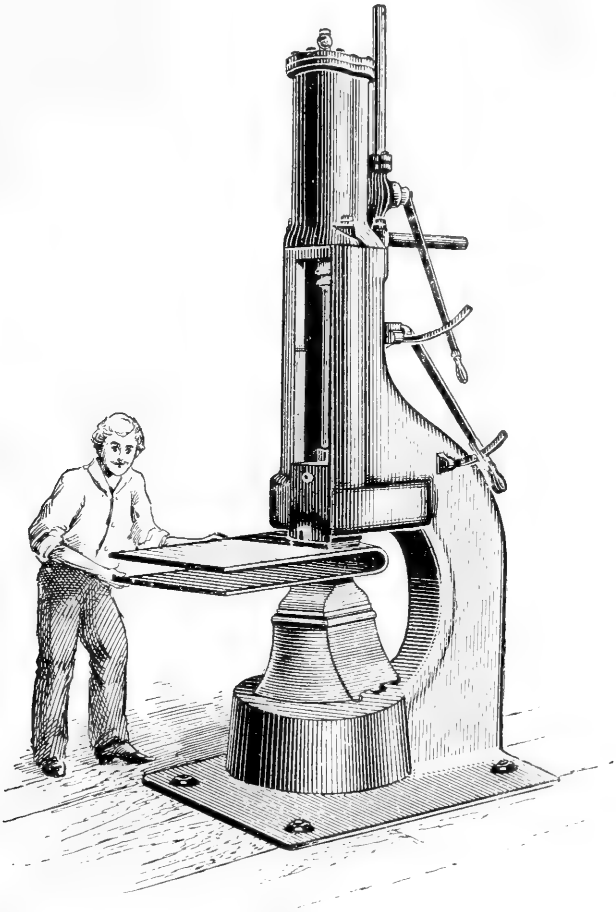


Fig. 6.

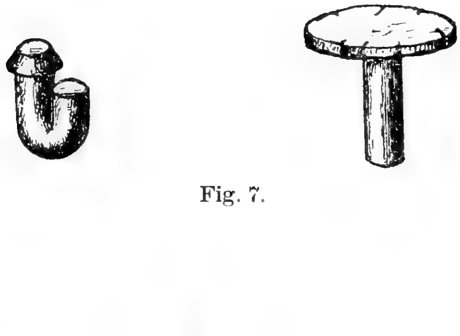


Fig. 7.

FIGURES ILLUSTRATING THE MANNER OF TESTING THE IRON FOR THE NEW BOILERS.

(See page 47.)

The dredging and reeling engines have been overhauled. The sounding engine is too small for its work. By being able to run the latter all the time, since the new reel, designed by the writer, has been in use, the nuisance of a cylinder full of water, every time they began to reel in, is now obviated. Although the reel is made of aluminum bronze, specimens of which showed a tensile strength of 93,520 pounds per square inch, it was found to be harder on one side than on the other. From this fact I judge that the copper and aluminum were not well mixed,* although the casting was made by the patentees. The reel is lighter and has a stronger shape than the steel ones, and it will not corrode.

The steering engine continues to work well. I have provided a shunt by which it may be made to exhaust into the air. An attachment by which it may be worked from the top of the pilot house is recommended.

The old exhaust fan and motor were displaced by the new boilers, and in their place have been erected a pair of No. 5 monogram exhausters and an orthodox steam-engine, which deliver more than double the quantity of air the original did. The relative economy of the two fans and motors, calculated in cubic feet of air delivered per pound of feed water used to propel the air, is as follows:

The Wise motor and No. 6 fan	1.00
The present engine and pair of No. 5 fans	21.86

The two steam cutters continue to perform excellent service. They have done more work than any other two Herreshoff boats the Government owns, but they have received unremitting attention. This has resulted from the hearty encouragement given to the engineer's department by the commanding officer; his appreciation of efficiency, and his willingness to sacrifice his own convenience to that end.

On stripping the wooden ceiling from the sides of the ship in the wake of the old bunkers, we found much corrosion of the hull on the inside. This has resulted from putting wet coal into the ship, the cold sides of which condense the moisture on their surface. The warm air, after the coal is removed, absorbs the moisture; the next charge of wet coal again moistens the plates, and this will continue as long as the present custom prevails.

The original Z dynamo and 8½ by 10 engine have been taken from the ship and replaced by a No. 3 dynamo and a 6½ by 8 engine. Much weight and space have been saved by this change. The new outfit gives the ship 120 lights of 10-candle power each, a gain of about 25 per cent. on the old one.

The old wooden boxes which carried the tiller ropes through the coal bunkers were defective and objectionable. Iron tubes and carriers, which are tight and serviceable, have been devised by the writer. They are represented in figures 8, 9, 10, and 11.

* Those two metals are of greatly different densities.

[From October 24, 1887, to July 1, 1888, by PASSED ASSISTANT ENGINEER C. R. ROELKER, U. S. Navy.]

The main engines and boilers have worked generally satisfactorily, and, with the exception of some slight repairs to a leaky bottom blow-pipe at Montevideo, Uruguay, all the incidental repairs and adjustments were made by the engineer force of the vessel and have caused no delay in her movements until her arrival at San Francisco, California. There the machinery, both main and auxiliary, was thoroughly overhauled and placed in an efficient condition, the shops of the Union Iron Works being utilized for such work as could not be done to advantage by the engineers' force of the vessel.

Only one boiler has been in use at a time, and during the greater portion of our steaming the grate surface of the boilers was reduced to 49½ and 45 square feet in order to steam more economically with a limited consumption of fuel. Leaks have continued to develop in the bottom of the boilers, the most active cause for this being undoubtedly the low temperature of the feed-water. The donkey-boiler has been used in port for lighting, heating, and ventilating the vessel and for running the steam-pumps whenever the fires could be hauled in the main boilers with due regard to safety and economy.

With the exception of a small quantity of anthracite coal remaining in the bunkers from the supply received at Norfolk, Virginia, and a few tons of Seattle and Wellington coals received at San Francisco, the fuel used has been Cardiff and Chilian coal. About 170 tons of the latter were obtained from the Alberto mine at Lota, Chili. The bulk of this coal is about 11 per cent. greater than that of Cardiff coal. It ignites easily and burns rapidly with a large flame; it does not cake, but breaks up into small particles, which run through the grate, but should be put back into the furnace. It forms large clinkers, which often cover the entire grate and are the principal part of the refuse. The quantity of refuse produced amounted to 7¼ per cent. of the quantity of coal consumed. Its evaporative power was about 75 per cent. of that of good Welsh coal. For economical reasons the consumption of coal was limited to 10½ tons per day. With this consumption the vessel maintained a speed of 8½ knots per hour in smooth water under steam alone, and attained a speed of 9 knots per hour on several occasions.

At Panama, March 21, the vessel was beached for the purpose of scraping and painting her bottom, which was quite foul, but unfortunately the slight rise and fall of the tide on that day left the greater part of the bottom inaccessible. During the latter part of June, however, she was placed on the hydraulic lifting dock of the Union Iron Works, at San Francisco, where her bottom was thoroughly cleaned and painted.

Temporary repairs were made to the leaky steam-piston of the Sigsbee Sounding Machine at Montevideo, whereby the working of the ma-

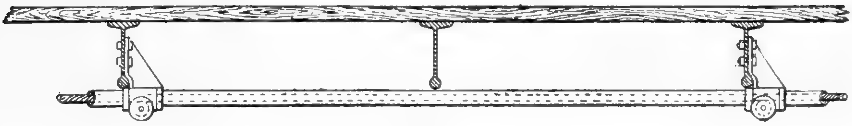


Fig. 8.

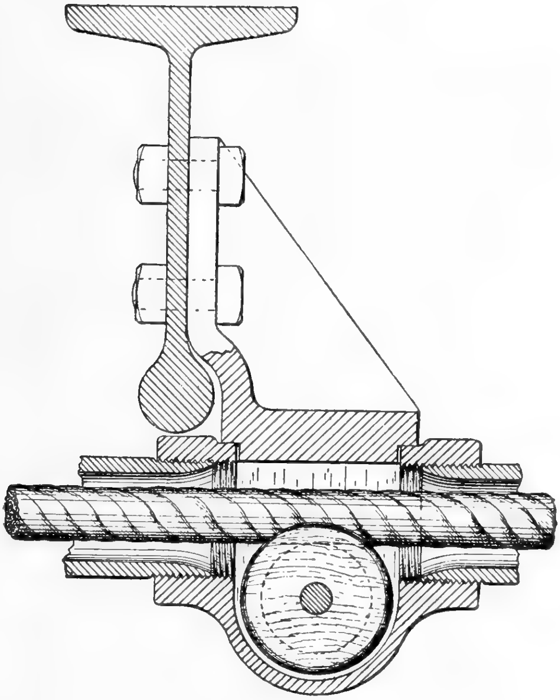


Fig. 9.

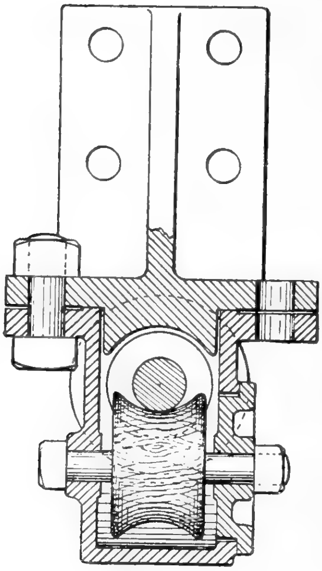


Fig. 10.

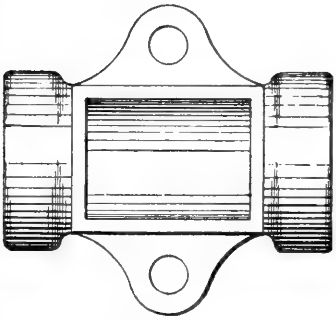


Fig. 11.

IRON TUBES AND CARRIERS FOR THE TILLER ROPES. (See page 49.)

chine was greatly improved. At San Francisco the piston was repaired in the most approved manner, and on a preliminary trial has worked very satisfactorily.

The steam cutter and steam gig have been thoroughly overhauled at San Francisco and placed in good working condition. Both received slight injuries to their machinery at Panama, without, however, causing a serious delay in their use.

The total number of nautical miles steamed since leaving Norfolk, Virginia, has been 16,320.4; the total amount of coal consumed for steaming, $879\frac{700}{2240}$ tons.

Trawling and dredging stations made by the U. S. Fish Commission Steamer Albatross, during the year and a half ending June 30, 1888.

Serial No.	Date.	Time.	Position. Latitude.	Position. Longitude.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Force.	Instrument used.
	1887.		° ′ ″	° ′ ″	°	°	°	Faths.					Knots.	
2736	Apr. 8	11 a. m.	Hampton Roads		48	46	46	11	S	E	4			S. B. T.
2737	Apr. 8	11.17 a. m.	do		48	46	47	12	S	E	4			Do
2738	Sept. 16	3.14 p. m.	36 52 00 N.	74 23 00 W.	70	70	38	958	gn. m	NNE	6	NW. by W	1	L. B. T.
2739	Sept. 17	8.03 a. m.	37 34 30	73 58 00	65	69	38.2	811	gy. m	NE	4	NNW	1	Do.
2740	Sept. 17	11.52 a. m.	37 40 00	73 50 00	65	70	38	1,011	br. oz	NE. by N	4	NW. by N	1½	Do.
2741	Sept. 17	3.49 p. m.	37 44 00	73 57 00	64	70	38	852	gn. m	NNE	4	N	1	Do.
2742	Sept. 17	6.25 p. m.	37 46 30	73 56 30	64	69	38	865	gn. m	NNE	2	NW. by N	1	Do.
2743	Sept. 18	8.06 a. m.	38 31 00	72 53 00	62	67	37.8	1,155	gn. oz	ESE	2–3	NW	1	Do.
2744	Sept. 18	11.48 a. m.	38 35 00	73 05 15	65	69	39	554	bu. m	E	2	N. by E	½	Do.
2745	Sept. 18	4.20 p. m.	38 42 00	73 05 30	67	68	41.8	224	gn. m	SE	2	NNE	½	Do.
2746	Sept. 18	5.14 p. m.	38 46 00	73 05 45	65	68	51.2	102	gr. s	SE	2	W	¾	Do.
2747	Sept. 19	6.05 a. m.	39 27 00	71 15 00	67	67	37.5	1,276	bu. m	NNW	2	S	1	Do.
2748	Sept. 19	10.53 a. m.	39 31 00	71 14 30	72	68	37.8	1,163	gy. m. for	SW	1	W	1	Do.
2749	Sept. 19	3.20 p. m	39 42 00	71 17 00	69	67	38.8	705	gn. oz	S	2–3	NW	½	Do.
2750	Nov. 27	6.52 p. m.	18 30 00	63 31 00	81	80	44.5	496	fne. gy. s	SSW	4	SE	1	2 S. D.
2751	Nov. 28	9.18 a. m.	16 54 00	63 12 00	81	81	40	687	bu. glob. oz	ESE	3	SSE	1⅞	L. B. T.
2752	Dec. 4	12.13 m.	13 34 00	61 04 00	82	82	48	281	bk. s	SE	2			Do.
2753	Dec. 4	1.31 p. m.	13 34 00	61 03 00	82	83	48	281	bk. s	NE	2			T.
2754	Dec. 5	12.09 m	11 40 00	58 33 00	85	84	38	880	glob. oz	SE. by S	2	S	2½	L. B. T.
2755	Dec. 7	12.03 m.	8 04 00	52 47 00	83	81	40	720	bu. m	SE. by E	3	S	1¼	Do.
2756	Dec. 14	10.06 a. m	3 22 00 S.	37 49 00	80	79	40.5	417	gy. sbk. sp	SE. by S	5	S. by E	¾	S. B. T.
2757	Dec. 16	4.32 p. m	6 59 00	34 47 00	81	79	79	20	brk. sh	SE. by S	4			S. D.
2758	Dec. 16	4.50 p. m.	6 59 30	34 47 00	81	79	79	20	brk. sh	SE. by S	4			Do.
2759	Dec. 16	4.59 p. m.	7 00 00	34 47 00	81	79	79	20	brk. sh	SE. by S	4			S. B. T.
2760	Dec. 18	3.33 p. m.	12 07 00	37 17 00	84	80	39.5	1,019	br. co	SE	1	S. ½ W	1	L. B. T.
2761	Dec. 26	12.06 m.	15 39 00	38 32 54	80	79	39	818	Pter. oz	SE. by S	1	SSE	2	Do.
2762	Dec. 30	6.05 a. m	23 08 00	41 34 00	72	70	57.1	59	bu. m	S	1	SSW	¼	S. D.
2763	Dec. 30	5.31 p. m	24 17 00	42 48 30	79	75	37.9	671	br. glob. oz	ENE	3	SW. ¼ S	1	L. B. T.
	1888.													
2764	Jan. 12	8.46 a. m.	36 42 00	56 23 00	69	68	......	11½	s. brk. sh	NW	3	S	½	Do.
2765	Jan. 12	9.10 a. m.	36 43 00	56 23 00	69	69	......	10½	s. brk. sh	NW	3	S	1	Do.
2766	Jan. 12	9.55 a. m.	36 47 00	56 23 00	69	68	......	10½	s. brk. sh	NW	3	S.	¾	Do.
2767	Jan. 13	12.42 p. m	40 03 00	58 56 00	66	64	......	52	fne. dk. s	NW	3	SSW	1	Do.
2768	Jan. 14	11.53 a. m.	42 24 00	61 38 30	62	61	......	43	dk. s. bk. sp	SSE	2	SW	1	Do.
2769	Jan. 15	11.33 a. m.	45 22 00	64 20 00	60	58	56.6	51½	gn. m. fne. s	N	3	S. ¾ W	¾	Do.
2770	Jan. 16	11.32 a. m.	48 37 00	65 46 00	55	52	......	58	gy. s. bk. sp	S	1	S	1½	Do.
2771	Jan. 17	11.29 a. m.	51 34 00	68 00 00	49	50	49.4	50½	gy. s. bk. sp	WSW	3	S. by W	1	Do.
2772	Jan. 17	4.02 p. m.	52 16 00	68 13 00	60	52	......	31½	fne. gy. s	N	4	S	½	Do.
2773	Jan. 17	5.13 p. m.	52 23 00	68 11 00	56	51	......	10	fne. gy. s	NNW	4	S	¼	S. B. T.

2774	Jan. 18	4.30 a. m	52 23 00		68 31 30	52	49	......	17	S. G	N. by W	4	SW. by W	¼	Do.
2775	Jan. 18	9.41 a. m	52 22 30		69 22 00	54	51	......	29½	S. St	NW	3	None	......	Do.
2776	Jan. 18	12.10 p. m.	52 41 00		69 55 30	53	51	......	21	S. G	W	1	None	......	Do.
2777	Jan. 19	1.18 p. m	52 38 00		70 10 30	57	51	......	19¾	G	W	2	None	......	Do.
2778	Jan. 23	10.15 a. m.	53 01 00		70 42 15	52	49	47.9	61	gy. s. bk. sp	ENE	2	E. by S	1	L. B. T.
2779	Jan. 23	11.39 a. m	53 06 00		70 40 30	52	49	46.9	77½	gn. oz	ENE	2	SSW	1¾	Do.
2780	Feb. 2	11.40 a. m.	53 01 00		73 42 30	54	51	46.9	369	gn. m	WNW	4	SW. by W	1	Do.
2781	Feb. 4	2.30 p. m.	51 52 00		73 41 00	51	51	49.9	348	bu. m	NW	3-5	NN. W	1/10	Do.
2782	Feb. 6	5.34 a. m.	51 12 00		74 13 30	46	49	47.9	258	bu. m	W	4-6	NW. by N	¾	S. B. T.
2783	Feb. 6	7.43 a. m.	51 02 30		74 08 30	46	49	47.9	122	bu. m	W	3-4	NW. by N	1	Do.
2784	Feb. 8	10.01 a. m.	48 41 00		74 24 00	55	55	51.9	194	bu. m	SE	3	W. by N	1	L. B. T.
2785	Feb. 8	2.08 p. m.	48 09 00		74 36 00	58	57	46.9	449	bu. m	SE	3	NW. by N	1½	Do.
2786	Feb. 9	12.46 p. m	46 46 00		75 16 30	60	57	54.9	57	gn. m	S	3	S. E	¼	Do.
2787	Feb. 9	1.18 p. m.	46 47 30		75 15 00	60	57	53.9	61	gn. m	S	3	SE. ½ E	½	Do.
2788	Feb. 11	4.25 p. m.	45 35 00		75 55 00	57	58	36.9	1,050	gn. m	SW	4	NW. by N	1	Do.
2789	Feb. 12	2.40 p. m.	42 36 00		75 28 00	61	60	35.9	1,342	bu. m	SSW	3	NNW	½	Do.
2790	Feb. 13	3.31 p. m.	39 21 00		74 42 00	62	62	35.9	1,287	gn. m	SSE	4	N. by E	1¾	Do.
2791	Feb. 14	9.47 a. m.	38 08 00		75 53 00	61	61	37.9	677	yl. m	SSE	4	ENE	½	Do.
2792	Mar. 2	3.27 p. m	00 37 00		81 00 00	80	77	42.9	401	gn. m	SW	2	N. by E	¾	Do.
2793	Mar. 3	6.28 a. m	01 03 00	N.	80 15 00	78	78	38.4	741	gn. m	SSE	2	NNE	1	Do.
2794	Mar. 5	1.52 p. m.	07 37 00		78 46 30	79	78	59.6	62	gy. s. bk. sp. brk. sh.	NNW	3	W	¼	S. B. T.
2795	Mar. 5	4.23 p. m.	07 57 00		78 55 00	79	78	64.1	33	gy. s. bk. sp. brk. sh	NNW	2	NE	½	L. B. T.
2796	Mar. 5	5.52 p. m.	08 05 00		78 51 00	80	78	......	33	gy. s. brk. sh	NW	2	NNE	1	Oyster.
2797	Mar. 5	6.10 p. m.	08 06 30		78 51 00	80	78	......	33	gy. s. brk. sh	NW	2	E. ¾ S	½	L. B. T.
2798	Mar. 5	7.04 p. m.	08 10 30		78 50 30	80	78	......	18	gy. s. brk. sh	NW	2	E. ¾ S	⅛	Do.
2799	Mar. 6	11.16 a. m.	08 44 00		79 09 00	76	75	......	29½	gn. m	WNW	0-2	WNW	1	Do.
2800	Mar. 30	10.32 a. m.	08 51 00		79 31 30	82	77	......	7	gn. m	E	2	SW	⅛	Do.
2801	Mar. 30	11.41 a. m.	08 47 00		79 29 30	83	78	......	14	gn. m	NE. by E	2	SSE	¼	Do.
2802	Mar. 30	1.04 p. m.	08 38 00		79 31 30	84	78	......	16	gn. m	NE	3	S. ½ W	1½	Do.
2803	Mar. 30	2.49 p. m	08 27 00		79 35 00	85	78	......	26	gn. m	NNE	3	S. ½ W	1¼	Do.
2804	Mar. 30	4.38 p. m.	08 16 30		79 37 45	85	81	......	47	gn. m	NNE	3	S. ¼ W	1½	Do.
2805	Mar. 30	8.04 p. m.	07 56 00		79 41 30	79	78	......	51½	gn. m	N. by W	3	SE. by E	1	Do.
2806	Apr. 3	4.05 p. m.	00 30 00		88 37 30	85	80	36.4	1,379	br. glob. oz	ESE	3	SW. by S	1½	Do.
2807	Apr. 4	5.05 a. m.	00 24 00	S.	89 06 00	79	79	38.5	812	glob. oz. co. m	ESE	2	S	¾	Do.
2808	Apr. 4	9.14 a. m.	00 36 30		89 19 00	79	79	39.9	634	co. s	ENE	3	SSW	2/10	Do.
2809	Apr. 4	2.23 p. m.	00 50 00		89 36 00	80	79	74.1	45	gy. s	ENE	2	SE. by S	1/10	S. B. T.
2810	Apr. 7	5.08 p. m.	01 22 00		89 39 30	85	81	......	6½	co. s	calm	0	N. by W	2/10	Tangles.
2811	Apr. 7	5.20 p. m.	01 21 30		89 39 30	85	81	......	19	co. s	calm	0	W	2/10	S. B. T.
2812	Apr. 7	5.37 p. m.	01 21 30		89 39 45	85	81	......	20	co. s	calm	0	W	2/10	Tangles.
2813	Apr. 7	5.48 p. m.	01 21 00		89 40 15	85	81	......	40	co. s	calm	0	W	⅛	S. Dredge.
2814	Apr. 9	5.17 p. m.	01 17 30		90 30 00	82	79	......	20	hrd	NE	3	W. ¾ S	2/10	Do.
2815	Apr. 9	5.27 p. m	01 17 30		90 30 15	82	79	......	33½	gy. s. bk. sp	NE	3	W. ¾ S	½	Tangles.
2816	Apr. 9	5.51 p. m.	01 17 00		90 31 30	81	79	......	78½	gy. s. fne. g	NE	3	NW. by W	½	Do.
2817	Apr. 15	9.23 a. m	00 46 00		89 42 00	83	80	46.9	271	wh. s	calm	0	WNW	1¼	S. B. T.
2818	Apr. 15	1.13 p. m.	00 29 00		89 54 30	85	83	43.9	392	wh. and bk. s	calm	0	NW. by N	¾	L. B. T.
2819	Apr. 15	6.02 p. m.	00 08 00		90 06 00	85	83	39.9	671	wh. s	SE	2	NW. by N	3/10	Do.
2820	Apr. 26	1.41 p. m.	18 43 00	N.	104 04 00	87	85	45.9	204	br. m	S	2	NW	¾	Do.
2821	Apr. 26	4.04 p. m.	18 52 00		104 10 30	87	84	53.9	117	br. m	S	2	NW	2	Do.
2822	Apr. 30	9.38 a. m.	24 16 00		110 22 00	76	73	......	21	gy. s. brk. sh	SSW	2	NW	½	S. B. T.
2823	Apr. 30	11.15 a. m.	24 18 00		110 22 00	76	73	......	26½	brk. sh	SSW	1	NNW	½	L. B. T.
2824	Apr. 30	11.23 a. m.	24 22 30		110 19 30	76	73	......	8	brk. sh	SSW	1	E	¼	Tangles.
2825	Apr. 30	11.35 a. m.	24 22 15		110 19 15	79	73	......	7	brk. co	SSW	1	E	¼	Ship dredge.

Trawling and dredging stations made by the U. S. Fish Commission Steamer Albatross—Continued.

Serial No.	Date.	Time.	Position. Latitude.	Position. Longitude.	Temperature. Air.	Temperature. Surface.	Temperature. Bottom.	Depth.	Character of bottom.	Wind. Direction.	Wind. Force.	Drift. Direction.	Drift. Force.	Instrument used.
	1888.		° ′ ″	° ′ ″	°	°	°	*Faths.*					*Knots.*	
2826	Apr. 30	3.07 p. m.	24 12 00	109 55 00	78	74	......	9½	sh	SSE	4	SE. by S.	2/10	Oyster dredge.
2827	Apr. 30	3.18 p. m.	24 11 45	109 55 00	78	74	......	10	sh	SSE	4	SE. by S	1/10	Do.
2828	Apr. 30	3.34 p. m.	24 11 30	109 55 00	78	74	......	10	sh	SSE	4	SE. by S	2/10	Do.
2829	May 1	8.18 a. m.	22 52 00	109 55 00	75	75	74.1	31	rky	SW. by W	0–1	SSW	1	Tangles.
2830	May 1	6.01 p. m.	23 33 00	110 37 00	67	67	74.1	66	fne. s.	WNW	3	NW	1½	L. B. T.
2831	May 2	12.15 p. m.	24 32 00	111 59 00	65	67	......	12	fne. gy. s.	NW. by W	3	NNW	½	Do.
2832	May 2	3.36 p. m.	24 38 00	112 17 30	63	60	56.4	51	gn. m	WNW	3	None	......	Do.
2833	May 2	3.54 p. m.	24 38 00	112 17 30	63	60	......	51	gn. m	WNW	3	NW	4/10	Tangles.
2834	May 3	7.31 a. m.	26 14 00	113 13 00	62	61	53.9	48	yl. m	NW by W	4	NNW	1½	L. B. T.
2835	May 4	7.24 a. m.	26 42 30	113 34 15	54	56	......	5½	gn. m	W	2	SE	3/10	Ship dredge.
2836	May 4	7.37 a. m.	26 42 30	113 34 15	60	57	......	6	gn. m	W	2	SE	3/10	Oyster dredge.
2837	May 5	4.24 p. m.	28 10 00	115 09 45	64	62	......	23	fne. s.	W	3	NE	1/10	Ship dredge.
2838	May 5	4.50 p. m.	28 12 00	115 09 00	64	62	......	44	gn. m	W	3	N	2/10	L. B. T.
2839	May 8	4.03 p. m.	33 08 00	118 40 00	58	61	41.4	414	gy. s.	W	3	WNW	1¾	Do.
2840	May 9	8.34 a. m.	34 11 00	120 15 00	55	54	43.9	27.6	gn. m	NW	2	NW	1	Do.

Record of hydrographic soundings of the U. S. Fish Commission Steamer Albatross during the year ending June 30, 1888.

Serial No.	Date.	Time.	Position.		Depth.	Character of bottom.	Temperature.			Remarks.
			Latitude.	Longitude.			Air.	Surface.	Bottom.	
	1887.		° ′ ″	° ′ ″	*Faths.*		°	°	°	
1090	Sept. 17	5.25 a.m.	37 37 00 N.	74 11 00 W.	352	hrd	64	70	39.5	C=W ½ kt.
1091	Sept. 18	5.06 a.m.	38 31 00	73 15 00	255	gy. s	62	68	41	
1092	Dec. 6	....	9 47 00	55 51 00	2,069	br. glob. oz	85	82	36.5	C=E 3½ kt.
1093	Dec. 8	12.03 p.m.	6 25 00	50 29 30	2,406	br. glob. oz	82	80	37.5	
1094	Dec. 9	9.00 p.m.	5 01 00	46 44 00	1,876	No specimen	80	80	....	Wire parted while heaving in.
1095	Dec. 11	11.32 a.m.	1 53 00	43 00 00	2,449	glob. oz	82	80	....	Ther. failed to capsize.
1096	Dec. 15	10.01 a.m.	4 38 00 S.	35 55 00	1,263	co	78	79	37.9	
1097	Dec. 17	5.00 p.m.	10 10 00	35 32 00	1,276	br. co	81	79	37.9	
1098	Dec. 31	1.27 a.m.	24 40 00	43 45 00	889	br. glob. oz	75	75	38.9	
1099	Dec. 31	7.10 a.m.	25 24 00	44 14 00	1,061	Pter. oz	75	75	38.9	
1100	Dec. 31	10.42 a.m.	25 45 00	44 38 00	1,099	br. glob. oz	78	75	38.9	
1101	Dec. 31	12.10 p.m.	25 51 00	44 48 00	1,019	br. glob. oz	78	75	38.9	
1102	Dec. 31	1.52 p.m.	25 41 00	44 48 00	945	br. glob. oz	78	76	38.4	
1103	Dec. 31	3.28 p.m.	25 42 00	44 58 30	777	br. glob. oz	78	76	37.9	
1104	Dec. 31	9.32 a.m.	26 23 00	45 31 30	756	br. glob. oz	77	76	37.9	
	1888.									
1105	Jan. 2	3.20 p.m.	31 05 00	49 45 00	78	s. and brk. sh	82	76	....	
1106	Jan. 3	7.40 a.m.	32 51 00	51 48 00	24	s. and g	71	71	....	
1107	Jan. 3	12.00 m.	33 17 00	52 19 00	11	gy. s	72	71	....	
1108	Jan. 3	4.00 p.m.	33 46 10	52 45 00	14	gy. s	72	70	....	
1109	Jan. 3	5.30 p.m.	33 55 00	52 53 00	14	fne. dk. s	70	70	....	
1110	Jan. 3	6.30 p.m.	34 01 00	53 00 00	11½	fne. dk. s	68	70	....	
1111	Jan. 3	7.40 p.m.	34 09 00	53 08 00	13	fne. dk. s	67	70	....	
1112	Jan. 12	11.00 a.m.	36 56 00	56 23 00	12	s. brk. sh	69	68	....	
1113	Mar. 31	5.33 a.m.	6 44 00 N.	80 27 00	1,927	gn. m	77	77	35.9	
1114	Apr. 1	4.50 a.m.	5 16 00	83 09 00	1,729	gn. m	80	79	36.9	
1115	Apr. 1	11.28 p.m.	4 18 00	85 14 00	1,882	dk. br. m. and for	82	82	35.9	
1116	Apr. 2	1.55 a.m.	4 14 00	85 11 00	1,657	dk. br. m. and for	83	83	35.9	
1117	Apr. 2	4.05 a.m.	4 2 00	85 25 30	1,724	gy. glob. oz	81	80	35.9	
1118	Apr. 2	3.57 p.m.	2 53 00	86 24 00	1,616	br. glob. oz	84	83	35.9	
1119	Apr. 3	9.01 a.m.	1 13 00	88 02 00	1,341	br. glob. oz	80	80	35.9	
1120	Apr. 7	7.43 a.m.	1 8 00 S.	89 39 00	287	hrd	80	78	....	
1121	Apr. 7	11.50 p.m.	1 23 00	89 58 00	286	gy. s. bk. sp	78	80	45.9	
1122	Apr. 8	2.31 a.m.	1 25 00	90 07 00	191	fne. gy. s	80	79	53.9	
1123	Apr. 13	8.55 p.m.	00 53 00	90 15 30	108	wh. s	81	79	58.1	
1124	Apr. 14	12.52 a.m.	00 53 30	90 05 30	139	wh. co. s	80	78	56.2	
1125	Apr. 14	2.28 a.m.	00 51 00	89 43 30	329	fne. gy. s	79	78	45.6	
1126	Apr. 17	8.03 p.m.	4 44 00 N.	93 02 00	1,976	rd. br. oz	83	83	35.9	
1127	Apr. 19	8.07 a.m.	8 26 00	95 30 00	1,997	gn. m	83	81	35.9	
1128	Apr. 20	12.06 p.m.	11 45 00	97 03 00	2,256	gn. m	84	84	35.9	
1129	Apr. 21	1.02 p.m.	14 33 00	98 14 00	1,862	gn. m	87	75	35.9	

Record of temperatures and specific gravities for the year and a half ending June 30, 1888.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1887.									
Sept. 5	1.30 p. m	Wharf of Columbia Iron Works, Baltimore, Md.		Low water surface.	75	*76	74	1.0030	1.005086
5	8.30 p. m	do		High water surface.	74	69	72	1.0034	1.005164
15	7.15 a. m	Fort McHenry		Surface	72	70	73	1.0038	1.005724
15	7.45 a. m	Fort Carroll		do	73	70	72	1.0040	1.005764
15	9 a. m	Chesapeake Bay, off mouth of Magothy River.		do	72	71	83	1.0048	1.008526
15	10 a. m	Chesapeake Bay, off Thomas' Point.		do	72	72	83	1.0063	1.010026
15	4 p. m	Chesapeake Bay, off Bloody Point.		do	73	75	80	1.0080	1.011160
15	5 p. m	Chesapeake Bay, off Plum Point.		do	73	74	81	1.0084	1.011739
15	6 p. m	Chesapeake Bay, off Tobois Island.		do	73	74	81	1.0088	1.012139
15	7 p. m	Chesapeake Bay, between Cedar and Point-no-Point.		do	74	73	81	1.0091	1.012739
15	8 p. m	Chesapeake Bay, off St. Jerome's Creek.		do	74	73	81	1.0096	1.012939
15	9 p. m	Chesapeake Bay, off mouth Potomac River.		do	75	72	81	1.0100	1.013339
15	10 p. m	Chesapeake Bay, off Smith's Point.		do	75	72	81	1.0124	1.015739
16	7 a. m	Off Cape Henry, Cape Henry bearing W. by S. (true) distance 20 minutes.		do	73	67	78	1.0214	1.024208
		° ′ ″	° ′ ″						
16	12 m	36 54 00 N.	74 46 30 W.	do	73	71	78	1.0228	1.025608
17	12 m	37 40 00	73 50 30	do	70	65	82	1.0228	1.026320
18	12 m	38 35 00	73 05 00	do	69	64	81	1.0230	1.026339
19	12 m	39 34 00	71 17 00	do	69	71	81	1.0234	1.026739
Nov. 22	12 m	34 57 00 N.	74 37 00	do	72	56	85	1.0230	1.027100
22	6 p. m			do	74	61	85	1.0232	1.027300
22	12 p. m			do	69	61	85	1.0232	1.027300
23	6 a. m			do	70	64	85	1.0234	1.027500
23	12 m	32 00 00 N.	72 20 00 W.	do	70	70	85	1.0235	1.027600
23	6 p. m			do	70	69	85	1.0231	1.027200
23	12 p. m			do	72	69	85	1.0232	1.027300
24	6 a. m			do	72	69	85	1.0235	1.027600
24	12 m	28 53 00 N.	70 27 00 W.	do	74	72	85	1.0235	1.027600
24	6 p. m			do	73	72	85	1.0238	1.027900
24	12 p. m			do	73	72	85	1.0232	1.027300
25	6 a. m			do	74	72	85	1.0233	1.027400
25	12 m	25 29 00 N.	68 13 00 W.	do	75	75	85	1.0234	1.027500
25	6 p. m			do	76	76	85	1.0236	1.027700
25	12 p. m			do	76	75	85	1.0236	1.027700
26	6 a. m			do	78	75	85	1.0232	1.027300
26	12 m	22 09 00 N.	66 20 00 W.	do	79	79	85	1.0232	1.027300
26	6 p. m			do	79	78	85	1.0234	1.027500
26	12 p. m			do	80	79	85	1.0234	1.027500
27	6 a. m			do	79	79	85	1.0232	1.027300
27	12 m	19 29 00 N.	63 41 00 W.	do	80	81	85	1.0230	1.027100
27	6 p. m			do	80	81	85	1.0230	1.027100
27	12 p. m			do	80	78	85	1.0230	1.027100
28	6 a. m			do	81	79	86	1.0235	1.027816
28	12 m	16 48 00 N.	63 12 00 W.	do	82	84	86	1.0233	1.027616
28	6 p. m			do	83	84	86	1.0234	1.027716
28	12 p. m			do	82	81	86	1.0234	1.027716
29	6 a. m			do	81	80	85	1.0235	1.027600
29	12 m	Sta. Lucia, West Indies, Harbor Port Castries.		do	82	81	86	1.0212	1.025516
Dec. 4	12 m	13 16 00 N.	61 04 30 W.	do	82	82	86	1.0234	1.027716
4	6 p. m			do	82	80	86	1.0234	1.027716
4	12 p. m			do	81	80	86	1.0234	1.027716
5	6 a. m			do	81	80	85	1.0236	1.027700
5	12 m	11 40 00 N.	58 35 00 W.	do	83	83	85	1.0236	1.027700
5	6 p. m			do	83	82	85	1.0237	1.027800

* Specimens retained in lower laboratory until they had acquired the temperature of the room.

Record of temperatures and specific gravities, etc.—Continued.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1887.									
Dec. 5	12 p. m			Surface	82	81	85	1.0238	1.027900
6	6 a. m			do	81	80	85	1.0240	1.028100
6	12 m	9 47 00 N.	55 51 30 W.	do	82	83	85	1.0240	1.028100
6	6 p. m			do	81	80	85	1.0234	1.027500
6	12 p. m			do	81	80	85	1.0234	1.027500
7	6 a. m			do	80	78	85	1.0240	1.028100
7	12 m	8 04 00 N.	52 47 00 W.	do	81	83	85	1.0240	1.028100
7	6 p. m			do	81	81	85	1.0240	1.028100
7	12 p. m			do	81	78	85	1.0236	1.027700
8	6 a. m			do	80	79	85	1.0240	1.028100
8	12 m	6 25 00 N.	50 09 00 W.	do	80	82	85	1.0240	1.028100
8	6 p. m			do	82	83	85	1.0240	1.028100
8	12 p. m			do	80	79	84	1.0242	1.028112
9	6 a. m			do	80	78	84	1.0242	1.028112
9	12 m	5 29 00 N.	47 42 00 W.	do	80	80	84	1.0242	1.028112
9	6 p. m			do	80	78	84	1.0242	1.028112
9	12 p. m			do	80	80	84	1.0242	1.028112
10	6 a. m			do	80	79	84	1.0243	1.028212
10	12 m	3 38 00 N.	45 06 30 W.	do	81	83	84	1.0244	1.028312
10	6 p. m			do	81	84	84	1.0242	1.028112
10	12 p. m			do	79	80	84	1.0242	1.028112
11	6 a. m			do	80	79	84	1.0242	1.028112
11	12 m	1 53 00 N.	43 00 00 W.	do	80	82	84	1.0244	1.028312
11	6 p. m			do	80	81	83	1.0250	1.028726
11	12 p. m			do	79	80	82	1.0246	1.028120
12	6 a. m			do	79	78	85	1.0244	1.028500
12	12 m	00 01 00 S.	41 01 00 W.	do	79	81	85	1.0244	1.028500
12	6 p. m			do	80	80	85	1.0246	1.028700
12	12 p. m			do	79	79	85	1.0246	1.028700
13	6 a. m			do	79	79	85	1.0246	1.028700
13	12 m	01 45 00 S.	39 11 00 W.	do	79	81	85	1.0246	1.028700
13	6 p. m			do	79	81	85	1.0244	1.028500
13	12 p. m			do	79	79	84	1.0246	1.028512
14	6 a. m			do	79	78	84	1.0247	1.028312
14	12 m	3 24 00 S.	37 46 00 W.	do	79	81	84	1.0250	1.028912
14	6 p. m			do	79	81	84	1.0250	1.028912
14	12 p. m			do	78	79	84	1.0248	1.028712
15	6 a. m			do	78	78	84	1.0248	1.028712
15	12 m	4 45 00 S.	35 47 30 W.	do	79	80	84	1.0246	1.028512
15	6 p. m			do	79	79	84	1.0250	1.028912
15	12 p. m			do	79	79	84	1.0250	1.028912
16	6 a. m			do	78	78	84	1.0248	1.028712
16	12 m	6 25 00 S.	34 19 00 W.	do	79	80	84	1.0250	1.028912
16	6 p. m			do	80	82	84	1.0250	1.028912
16	12 p. m			do	78	78	84	1.0250	1.028912
17	6 a. m			do	78	77	84	1.0252	1.029112
17	12 m	9 36 00 S.	35 04 00 W.	do	79	80	84	1.0248	1.028712
17	6 p. m			do	79	81	84	1.0250	1.028912
17	12 p. m			do	78	78	84	1.0248	1.028712
18	6 a. m			do	77	77	84	1.0246	1.028512
18	12 m	11 52 05 S.	36 57 30 W.	do	78	80	84	1.0250	1.028912
18	6 p. m			do	80	82	84	1.0250	1.028912
18	12 p. m			do	78	78	84	1.0250	1.028912
19	6 a. m			do	78	77	84	1.0250	1.028912
22	12 m	Bahia, Brazil		do	79	80	81	1.0256	1.028939
25	12 p. m			do	78	78	81	1.0254	1.028739
26	6 a. m			do	78	78	80	1.0256	1.028760
26	12 m	15 39 00 S.	38 32 54 W.	do	79	80	81	1.0254	1.028739
26	6 p. m			do	81	83	80	1.0256	1.028760
26	12 p. m			do	78	79	80	1.0254	1.028560
27	6 a. m	Abrolhos Islands		do	76	78	80	1.0256	1.028760
28	6 p. m			do	78	82	80	1.0252	1.028360
28	12 p. m			do	77	78	80	1.0254	1.028560
29	6 a. m			do	77	75	80	1.0253	1.028460
29	12 m	21 09 00 S.	39 41 00 W.	do	79	79	80	1.0254	1.028560
29	6 p. m			do	76	77	79	1.0255	1.028483
29	12 p. m			do	74	75	75	1.0260	1.028265
30	6 a. m			do	70	72	75	1.0256	1.027865
30	12 m	23 43 00 S.	42 10 30 W.	do	75	75	75	1.0258	1.028065
30	6 p. m			do	75	77	75	1.0258	1.028065

Record of temperatures and specific gravities, etc.—Continued.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1887.									
Dec. 30	12 p. m			Surface	75	75	75	1.0260	1.028265
31	6 a. m			do	75	75	75	1.0260	1.028265
31	12 m	25 51 00 S.	44 46 00 W.	do	75	78	75	1.0262	1.028465
31	6 p. m			do	76	78	75	1.0262	1.028465
31	12 p. m			do	76	76	75	1.0260	1.028265
1888.									
Jan. 1	6 a. m	27 23 00 S.	46 36 30 W.	do	75	75	75	1.0262	1.028465
1	12 m	27 54 00 S.	47 03 00 W.	do	74	75	75	1.0260	1.028265
1	6 p. m	28 35 00 S.	47 39 00 W.	do	75	76	75	1.0260	1.028265
1	12 p. m	29 15 00 S.	48 15 00 W.	do	74	73	75	1.0254	1.027665
2	6 a. m	29 55 00 S.	48 51 00 W.	do	74	72	75	1.0252	1.027465
2	12 m	30 37 00 S.	49 27 00 W.	do	75	75	75	1.0252	1.027465
2	6 p. m	31 17 00 S.	50 10 00 W.	do	75	81	75	1.0250	1.027265
2	12 p. m	31 57 00 S.	50 53 00 W.	do	74	74	75	1.0240	1.026265
3	6 a. m	32 37 00 S.	51 36 00 W.	do	71	71	75	1.0228	1.025065
3	12 m	33 17 00 S.	52 19 00 W.	do	71	72	75	1.0226	1.024865
3	6 p. m	33 43 00 S.	53 01 00 W.	do	70	70	74	1.0226	1.024686
3	12 p. m	34 09 00 S.	53 43 00 W.	do	68	66	70	1.0230	1.024450
4	6 a. m	34 35 00 S.	54 25 00 W.	do	68	65	70	1.0212	1.022650
4	12 m	35 03 00 S.	55 45 00 W.	do	71	71	70	1.0084	1.009850
5	12 m	Harbor of Montevideo		do	74	78	70	1.0022	1.003650
9	6 p. m	Harbor of Montevideo. Pampero.		do	69	60	70	1.0016	1.003050
11	12 p. m	35 39 00 S.	56 20 00 W.	do	71	73	70	1.0116	1.013050
12	6 a. m	36 28 00 S.	56 25 00 W.	do	68	70	70	1.0170	1.018450
12	12 m	37 04 00 S.	56 30 00 W.	do	68	70	70	1.0244	1.025850
12	6 p. m	37 48 00 S.	56 58 00 W.	do	69	83	70	1.0248	1.026250
12	12 p. m	38 32 00 S.	57 30 00 W.	do	64	68	70	1.0246	1.026050
13	6 a. m	39 16 00 S.	57 58 00 W.	do	61	64	70	1.0244	1.025850
13	12 m	39 59 30 S.	58 53 00 W.	do	61	65	70	1.0244	1.025850
13	6 p. m	40 35 00 S.	59 34 00 W.	do	61	63	70	1.0244	1.025850
13	12 p. m	41 11 00 S.	60 15 00 W.	do	60	59	70	1.0244	1.025850
14	6 a. m	41 47 00 S.	60 56 00 W.	do	60	60	69	1.0248	1.026087
14	12 m	42 24 00 S.	61 38 30 W.	do	61	62	69	1.0248	1.026087
14	6 p. m	43 08 00 S.	62 21 00 W.	do	61	64	69	1.0248	1.026087
14	12 p. m	43 52 00 S.	63 04 00 W.	do	58	59	70	1.0244	1.025850
15	6 a. m	44 36 00 S.	63 40 00 W.	do	58	59	70	1.0244	1.025850
15	12 m	45 22 00 S.	64 20 00 W.	do	58	60	69	1.0246	1.025887
15	6 p. m	46 10 00 S.	64 42 00 W.	do	55	63	68	1.0246	1.025736
15	12 p. m	46 58 00 S.	65 04 00 W.	do	51	56	66	1.0250	1.025840
16	6 a. m	47 46 00 S.	65 26 00 W.	do	52	54	66	1.0248	1.025640
16	12 m	48 37 00 S.	65 46 00 W.	do	55	58	66	1.0248	1.025640
16	6 p. m	49 21 00 S.	66 22 00 W.	do	55	57	65	1.0250	1.025690
16	12 p. m	50 05 00 S.	67 02 00 W.	do	51	53	65	1.0250	1.025690
17	6 a. m	51 49 00 S.	67 38 00 W.	do	50	49	65	1.0250	1.025690
17	12 m	51 34 23 S.	68 00 00 W.	do	50	49	66	1.0242	1.025040
17	6 p. m	Cape Virgins, Straits Magellan.		do	50	50	66	1.0242	1.025040
18	6 a. m	Possession Bay, Straits Magellan.		do	49	52	65	1.0244	1.025090
18	1 p. m	Gregory Bay, Straits Magellan.		do	51	58	65	1.0232	1.023890
19	6 p. m	Elizabeth Island, Straits Magellan.		do	49	58	65	1.0232	1.023890
24	12 m	Sandy Point, Straits Magellan.		do	51	55	66	1.0234	1.024240
Feb. 1	12 m	Borja Bay, Straits Magellan		do	48	59	66	1.0230	1.023840
2	12 m	Ocean Reach, Straits Magellan.		do	51	55	66	1.0216	1.022440
3	1 p. m	Port Churruca, Straits Magellan.		do	52	53	66	1.0214	1.013240
4	8 a. m	Otter Bay, Smyth Channel		do	51	53	66	1.0194	1.020240
4	1 p. m	Mayne Channel		do	52	52	66	1.0194	1.020240
5	12 m	Mayne Harbor		do	51	51	66	1.0174	1.018240
6	12 m	Latitude Cove		do	51	50	66	1.0171	1.017940
7	12 m	Wide Channel		do	50	49	66	1.0166	1.017440
7	5 p. m	Eyre Sound		do	50	50	65	1.0080	1.008690
7	8 p. m	Port Grappler		do	53	52	70	1.0140	1.015450
8	12 m	Messier Channel		do	56	56	70	1.0130	1.014450
8	8 p. m	Island Harbor		do	57	57	70	1.0082	1.009650

Record of temperatures and specific gravities, etc.—Continued.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1888.									
Feb. 9	8 a. m	Gulf of Penas		Surface	57	64	70	1.0206	1.022050
9	6 p. m	Port Otway		...do	58	68	70	1.0226	1.023050
11	12 m	46 14 00 S.	75 46 00 W.	...do	58	58	70	1.0232	1.024650
11	6 p. m	45 25 00	75 38 00	...do	58	57	70	1.0236	1.025050
11	12 p. m	44 36 00	75 30 00	...do	57	55	70	1.0236	1.025050
12	6 a. m	43 45 00	75 21 00	...do	58	56	70	1.0240	1.025450
12	12 m	42 56 00	75 16 00	...do	60	62	70	1.0242	1.025650
12	6 p. m	42 10 00	75 09 00	...do	58	60	70	1.0240	1.025450
12	12 p. m	41 24 00	75 02 00	...do	61	58	70	1.0240	1.025450
13	6 a. m	40 39 00	74 55 00	...do	62	60	70	1.0242	1.025650
13	12 m	39 50 00	74 47 55	...do	62	63	70	1.0242	1.025650
13	6 p. m	39 10 00	74 33 00	...do	64	62	70	1.0242	1.025650
13	12 p. m	38 28 00	74 18 00	...do	63	63	70	1.0242	1.025650
14	6 a. m	37 49 00	74 02 00	...do	65	66	70	1.0244	1.025850
14	12 m	37 08 00	73 49 00	...do	60	62	70	1.0246	1.026050
14	6 p. m	Lota, Chili		...do	65	68	68	1.0250	1.026136
20	12 m	Tomè, Chili		...do	62	70	77	1.0246	1.027218
20	6 p. m	36 01 00 S.	73 13 00 W.	...do	59	62	77	1.0242	1.026818
20	12 p. m	35 06 00	73 29 00	...do	62	60	76	1.0242	1.026632
21	6 a. m	34 13 00	73 45 00	...do	67	64	76	1.0240	1.026432
21	12 m	33 21 00	74 01 30	...do	68	69	76	1.0240	1.026432
21	6 p. m	32 33 00	74 16 00	...do	68	68	76	1.0240	1.026432
21	12 p. m	31 45 00	74 30 00	...do	68	67	76	1.0240	1.026432
22	6 a. m	30 57 00	74 44 00	...do	67	67	76	1.0240	1.026432
22	12 m	30 09 00	74 58 00	...do	69	70	76	1.0240	1.026432
22	6 p. m	29 21 00	75 12 00	...do	70	71	76	1.0242	1.026632
22	12 p. m	28 33 00	75 26 00	...do	71	70	76	1.0244	1.026832
23	6 a. m	27 45 00	75 39 00	...do	70	70	76	1.0244	1.026832
23	12 m	26 57 00	75 53 00	...do	73	73	76	1.0246	1.027032
23	6 p. m	26 11 00	76 08 00	...do	72	71	76	1.0246	1.027032
23	12 p. m	25 25 00	76 21 00	...do	72	71	76	1.0250	1.027432
24	6 a. m	24 39 00	76 36 00	...do	73	73	76	1.0248	1.027232
24	12 m	23 52 00	76 51 00	...do	73	75	76	1.0250	1.027432
24	6 p. m	23 05 00	77 08 00	...do	76	75	76	1.0250	1.027432
24	12 p. m	22 18 00	77 25 00	...do	75	73	77	1.0246	1.027032
25	6 a. m	21 31 00	77 43 00	...do	73	73	79	1.0259	1.027983
25	12 m	20 44 00	78 00 00	...do	77	76	79	1.0250	1.027983
25	6 p. m	19 56 00	78 14 00	...do	76	75	79	1.0246	1.027583
25	12 p. m	19 06 00	78 29 00	...do	74	74	79	1.0250	1.027983
26	6 a. m	18 20 00	78 42 00	...do	75	74	79	1.0250	1.027983
26	12 m	17 29 00	78 57 00	...do	76	76	79	1.0246	1.027583
26	6 p. m	16 38 00	79 10 00	...do	75	75	79	1.0246	1.027583
26	12 p. m	15 49 00	79 21 00	...do	75	75	79	1.0246	1.027583
27	6 a. m	14 58 00	79 32 00	...do	75	75	79	1.0246	1.027583
27	12 m	14 07 00	79 49 00	...do	77	77	79	1.0244	1.027383
27	6 p. m	13 16 00	80 02 00	...do	77	77	79	1.0246	1.027583
27	12 p. m	12 26 00	80 15 00	...do	75	75	79	1.0244	1.027383
28	6 a. m	11 37 00	80 25 00	...do	76	75	79	1.0244	1.027383
28	12 m	10 44 00	80 43 00	...do	77	77	79	1.0244	1.027383
28	6 p. m	9 54 00	80 57 00	...do	77	78	79	1.0246	1.027583
28	12 p. m	9 03 00	81 12 00	...do	76	77	79	1.0242	1.027183
29	6 a. m	8 13 00	81 25 00	...do	75	75	79	1.0240	1.026983
29	12 m	7 21 00	81 40 00	...do	76	78	79	1.0240	1.026983
29	6 p. m	6 36 00	81 46 00	...do	76	76	79	1.0240	1.026983
29	12 p. m	5 52 00	81 51 00	...do	75	75	80	1.0238	1.026960
Mar. 1	6 a. m	5 06 00	81 58 00	...do	74	74	80	1.0240	1.027160
1	12 m	4 22 00	82 03 00	...do	75	80	80	1.0242	1.027360
1	6 p. m	3 32 00	81 50 00	...do	74	75	80	1.0240	1.027160
1	12 p. m	2 41 00	81 36 00	...do	73	74	80	1.0238	1.026960
2	6 a. m	1 53 00	81 23 00	...do	73	73	80	1.0238	1.026960
2	12 m	1 01 00	81 09 00	...do	76	78	80	1.0236	1.026760
2	6 p. m	0 23 00	80 53 00	...do	77	79	80	1.0236	1.026760
2	12 p. m	0 15 00 N.	80 36 00	...do	78	77	80	1.0234	1.026560
3	6 a. m	0 53 00	80 21 00	...do	78	77	80	1.0230	1.026160
3	12 m	1 30 00	80 04 00	...do	80	81	80	1.0228	1.025960
3	6 p. m	2 16 00	79 51 00	...do	81	80	80	1.0226	1.025760
3	12 p. m	3 02 00	79 37 00	...do	78	78	80	1.0226	1.025760
4	6 a. m	3 49 00	79 25 00	...do	76	76	80	1.0230	1.026160
4	12 m	4 35 00	79 11 00	...do	77	77	80	1.0226	1.025760

Record of temperatures and specific gravities, etc.—Continued.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1888.									
Mar. 4	6 p. m	5 17 00	78 50 00	Surface	77	77	80	1. 0226	1. 025760
4	12 p. m	5 59 00	78 25 00	do	77	78	80	1. 0222	1. 025360
5	6 a. m	6 42 00	78 08 00	do	77	76	80	1. 0222	1. 025360
5	12 m	7 24 00	78 45 00	do	78	80	80	1. 0222	1. 025360
5	6 p. m	7 44 00	78 51 00	do	78	79	80	1. 0228	1. 025960
5	12 p. m	8 05 00	78 59 00	do	73	76	80	1. 0230	1. 026160
6	6 a. m	8 24 00	79 04 00	do	75	75	80	1. 0230	1. 026160
6	12 m	8 46 00 Panama Bay	79 10 30	do	76	79	80	1. 0230	1. 026160
30	6 p. m	8 11 00 N.	79 38 00 W.	do	77	86	83	1. 0230	1. 026726
30	12 p. m	7 33 00	79 45 00	do	75	78	83	1. 0230	1. 026726
31	6 a. m	6 44 00	80 27 00	do	77	77	83	1. 0230	1. 026726
31	12 m	6 15 00	80 59 30	do	80	80	83	1. 0230	1. 026726
31	6 p. m	5 57 00	81 44 00	do	81	84	83	1. 0228	1. 026526
31	12 p. m	5 39 00	82 29 00	do	80	80	83	1. 0226	1. 026326
Apr. 1	6 a. m	5 21 00	83 14 00	do	83	81	83	1. 0224	1. 026126
1	12 m	5 01 00	84 00 00	do	84	85	83	1. 0222	1. 025926
1	6 p. m	4 36 00	84 31 00	do	85	88	83	1. 0222	1. 025926
1	12 p. m	4 11 00	85 02 00	do	82	82	83	1. 0222	1. 025926
2	6 a. m	3 46 00	85 33 00	do	82	84	83	1. 0222	1. 025926
2	12 m	3 22 00	86 05 00	do	83	83	83	1. 0220	1. 025726
2	6 p. m	2 46 00	86 38 00	do	82	84	83	1. 0222	1. 025926
2	12 p. m	2 10 00	87 11 00	do	81	81	83	1. 0222	1. 025926
3	6 a. m	1 34 00	87 42 00	do	79	80	83	1. 0226	1. 026326
3	12 m	00 57 00	88 15 00	do	81	82	83	1. 0228	1. 026526
3	6 p. m	00 33 00	88 32 00	do	80	85	83	1. 0230	1. 026726
3	12 p. m	00 09 00	88 49 00	do	79	80	83	1. 0232	1. 026926
4	6 a. m	00 15 00 S.	89 06 00	do	79	79	83	1. 0234	1. 027126
4	12 m	00 40 00	89 24 00	do	79	82	83	1. 0234	1. 027126
5	12 m	Wreck Bay, Chatham Island		do	79	81	86	1. 0234	1. 027716
7	12 m	Hood Island		do	80	82	86	1. 0240	1. 028316
8	12 m	Charles Island		do	80	83	86	1. 0236	1. 027916
10	12 m	Albemarle Island Elizabeth Bay		do	79	81	86	1. 0236	1. 027916
11	6 p. m	James Island		do	79	79	86	1. 0234	1. 027716
15	12 m	00 36 00 S.	89 50 00 W.	do	83	85	86	1. 0236	1. 027916
15	6 p. m	00 17 00	90 06 00	do	83	85	86	1. 0234	1. 027716
15	12 p. m	00 02 00 N.	90 20 00	do	81	82	86	1. 0230	1. 027316
16	6 a. m	00 21 00	90 36 00	do	81	80	86	1. 0230	1. 027316
16	12 m	00 42 00	90 51 30	do	83	85	86	1. 0232	1. 027516
16	6 p. m	1 26 00	91 16 00	do	82	82	86	1. 0230	1. 027316
16	12 p. m	2 10 00	91 41 00	do	79	80	86	1. 0230	1. 027316
17	6 a. m	3 07 00	92 06 00	do	81	80	86	1. 0228	1. 027116
17	12 m	3 45 00	92 32 00	do	85	86	86	1. 0230	1. 027316
17	6 p. m	4 21 00	92 46 00	do	84	84	86	1. 0224	1. 026716
17	12 p. m	4 57 00	93 02 00	do	82	81	86	1. 0220	1. 026316
18	6 a. m	5 33 00	93 16 00	do	81	82	86	1. 0216	1. 025916
18	12 m	6 19 00	93 30 30	do	82	82	86	1. 0216	1. 025916
18	6 p. m	6 56 00	94 03 00	do	82	82	86	1. 0220	1. 026316
18	12 p. m	7 33 00	94 36 00	do	81	81	86	1. 0220	1. 026316
19	6 a. m	8 10 00	95 09 00	do	81	80	86	1. 0220	1. 026316
19	12 m	8 47 00	95 42 00	do	82	82	86	1. 0224	1. 026716
19	6 p. m	9 32 00	96 02 00	do	82	82	86	1. 0220	1. 026316
19	12 p. m	10 17 00	96 23 00	do	81	82	86	1. 0220	1. 026316
20	6 a. m	11 02 00	96 42 00	do	82	82	86	1. 0222	1. 026516
20	12 m	11 45 00	97 03 00	do	84	84	86	1. 0222	1. 026516
20	6 p. m	12 25 00	97 19 00	do	84	84	86	1. 0224	1. 026716
20	12 p. m	13 07 00	97 35 00	do	83	83	86	1. 0224	1. 026716
21	6 a. m	13 45 00	97 53 00	do	83	83	86	1. 0224	1. 026716
21	12 m	14 28 00	98 09 00	do	85	86	73	1. 0250	1. 026924
21	6 p. m	14 57 00	98 35 00	do	85	86	73	1. 0252	1. 027124
21	12 p. m	15 32 00	99 02 00	do	84	84	73	1. 0252	1. 027124
22	6 a. m	15 53 00	99 21 00	do	83	83	73	1. 0250	1. 026924
24	12 m	Harbor Acapulco		do	83	85	73	1. 0252	1. 027124
24	12 p. m	16 52 00 N.	100 23 00 W.	do	82	81	73	1. 0250	1. 026924
25	6 a. m	17 07 00	101 04 00	do	83	81	73	1. 0250	1. 026924
25	12 m	17 19 00	101 28 00	do	85	86	73	1. 0250	1. 026924
25	6 p. m	17 37 00	102 05 00	do	84	84	73	1. 0250	1. 026924
25	12 p. m	17 56 00	102 43 00	do	83	82	73	1. 0248	1. 026724
26	6 a. m	18 14 00	103 19 00	do	83	80	73	1. 0248	1. 026724

Record of temperatures and specific gravities, etc.—Continued.

Date.	Time of day.	Latitude.	Longitude.	Depth.	Temperature by attached thermometer.	Temperature of air.	Temperature of specimen at time specific gravity was taken.	Specific gravity.	Specific gravity reduced to 60° Fah.
1888.									
Apr. 26	12 m.	18 33 00	103 57 00	Surface	85	88	73	1.0248	1.026724
26	6 p.m.	19 00 00	104 27 00	do	83	84	73	1.0250	1.026924
26	12 p.m.	19 28 00	104 58 00	do	83	82	73	1.0250	1.026924
27	6 a.m.	19 54 00	105 28 00	do	80	81	73	1.0250	1.026924
27	12 m.	20 22 00	105 59 00	do	79	78	73	1.0250	1.026924
27	6 p.m.	20 48 00	106 28 00	do	78	77	77	1.0244	1.027018
27	12 p.m.	21 18 00	106 57 00	do	76	75	77	1.0246	1.027218
28	6 a.m.	21 42 00	107 26 00	do	76	74	77	1.0244	1.027018
28	12 m.	22 15 00	107 58 30	do	75	75	77	1.0248	1.027418
28	6 p.m.	22 47 00	108 33 00	do	74	74	77	1.0248	1.027418
28	12 p.m.	23 19 00	109 10 00	do	73	73	77	1.0246	1.027218
29	6 a.m.	23 51 00	109 43 00	do	72	76	77	1.0246	1.027218
29	12 m.	24 22 00 La Pay Bay	110 20 00	do	75	75	77	1.0248	1.027418
30	9 a.m.	Pichilinque Bay		do	72	73	77	1.0250	1.027618
30	12 p.m.	Entrance Gulf of California		do	75	76	68	1.0264	1.027536
May 1	6 a.m.	Off Cape San Lucas		do	74	75	68	1.0264	1.027536
1	12 m.	23 01 00 N.	110 10 00 W.	do	68	68	67	1.0265	1.027487
1	6 p.m.	23 24 00	110 37 00	do	67	66	67	1.0262	1.027187
1	12 p.m.	23 45 00	111 05 00	do	65	64	67	1.0262	1.027187
2	6 a.m.	24 07 00	111 32 00	do	63	62	68	1.0260	1.027136
2	12 m.	24 31 00	112 00 00	do	67	65	68	1.0260	1.027136
2	6 p.m.	25 03 00	112 23 00	do	60	63	68	1.0256	1.026736
2	12 p.m.	25 35 00	112 45 00	do	62	61	68	1.0254	1.026536
3	6 a.m.	26 08 00	113 09 00	do	61	59	67	1.0256	1.026587
3	12 m.	26 40 30	113 31 00	do	59	61	67	1.0260	1.026987
4	12 m.	26 49 00	113 59 00	do	59	60	68	1.0256	1.026736
4	6 p.m.	27 09 00	114 17 00	do	58	60	68	1.0256	1.026736
4	12 p.m.	27 30 00	114 35 00	do	60	59	68	1.0256	1.026736
5	6 a.m.	27 48 00	114 52 00	do	59	59	68	1.0256	1.026736
5	12 p.m.	29 08 00	115 44 00	do	60	60	67	1.0252	1.026187
6	6 a.m.	29 37 00	116 03 00	do	59	59	67	1.0252	1.026187
6	12 m.	30 08 00	116 20 00	do	60	62	67	1.0254	1.026387
6	6 p.m.	30 43 00	116 38 00	do	61	60	66	1.0256	1.026440
6	12 p.m.	31 18 00	116 57 00	do	61	60	66	1.0256	1.026440
7	6 a.m.	31 54 00	117 14 00	do	60	59	66	1.0254	1.026240
7	12 m.	32 29 00	117 33 00	do	61	59	66	1.0252	1.026040
7	6 p.m.	St. Clemente Island		do	60	58	63	1.0260	1.026411
8	12 p.m.	33 34 00 N.	119 17 00 W.	do	59	56	65	1.0258	1.026490
9	6 a.m.	33 59 00	119 56 00	do	54	54	64	1.0260	1.026548
9	12 m.	34 24 00	120 26 00	do	55	55	64	1.0260	1.026548
9	6 p.m.	34 52 00	120 48 00	do	54	54	64	1.0260	1.026548
9	12 p.m.	35 20 00	121 10 00	do	54	54	64	1.0256	1.026148
10	6 a.m.	35 49 00	121 33 00	do	52	54	64	1.0256	1.026148
10	12 m.	36 17 00	121 55 00	do	53	53	64	1.0256	1.026148
10	6 p.m.	Off Monterey Bay		do	52	53	64	1.0256	1.026148
10	12 p.m.	Entrance San Francisco Bay, Harbor San Francisco.		do	51	51	64	1.0256	1.026148
June 19	1.01 p.m.*	¼ mile West Yerba Buena		do	63	65	69	1.0186	1.019887
19	1.01 p.m.*	¼ mile West Yerba Buena		Bottom	62	65	69	1.0202	1.021487
19	1.45 p.m. †	¼ mile W. S. W. Saucelito		Surface	63	65	69	1.0186	1.019887
19	1.45 p.m. †	¼ mile W. S. W. Saucelito		Bottom	62	65	69	1.0202	1.021487
19	1.57 p.m. ‡	⅛ mile off Yellow Bluff		Surface	63	65	69	1.0174	1.018687
19	1.57 p.m. ‡	⅛ mile off Yellow Bluff		Bottom	62	65	69	1.0204	1.021687
19	2.20 p.m. §	Alcatraz, N. by E. ¼ mile		Surface	62½	64	69	1.0186	1.019887
19	2.20 p.m. §	Alcatraz, N. by E. ¼ mile		Bottom	61	64	69	1.0202	1.021487
19	2.49 p.m. ‖	Yerba Buena Light, 1 mile		Surface	62½	64	69	1.0184	1.019687
19	2.49 p.m. ‖	Yerba Buena Light, 1 mile		Bottom	62	64	69	1.0194	1.020687

* 0.16 before low water. † 0.28 after low water. ‡ 0.40 after low water.
§ 1.03 after low water. ‖ 1.32 after low water.

N. B. Miller,
Apothecary, U. S. Navy.

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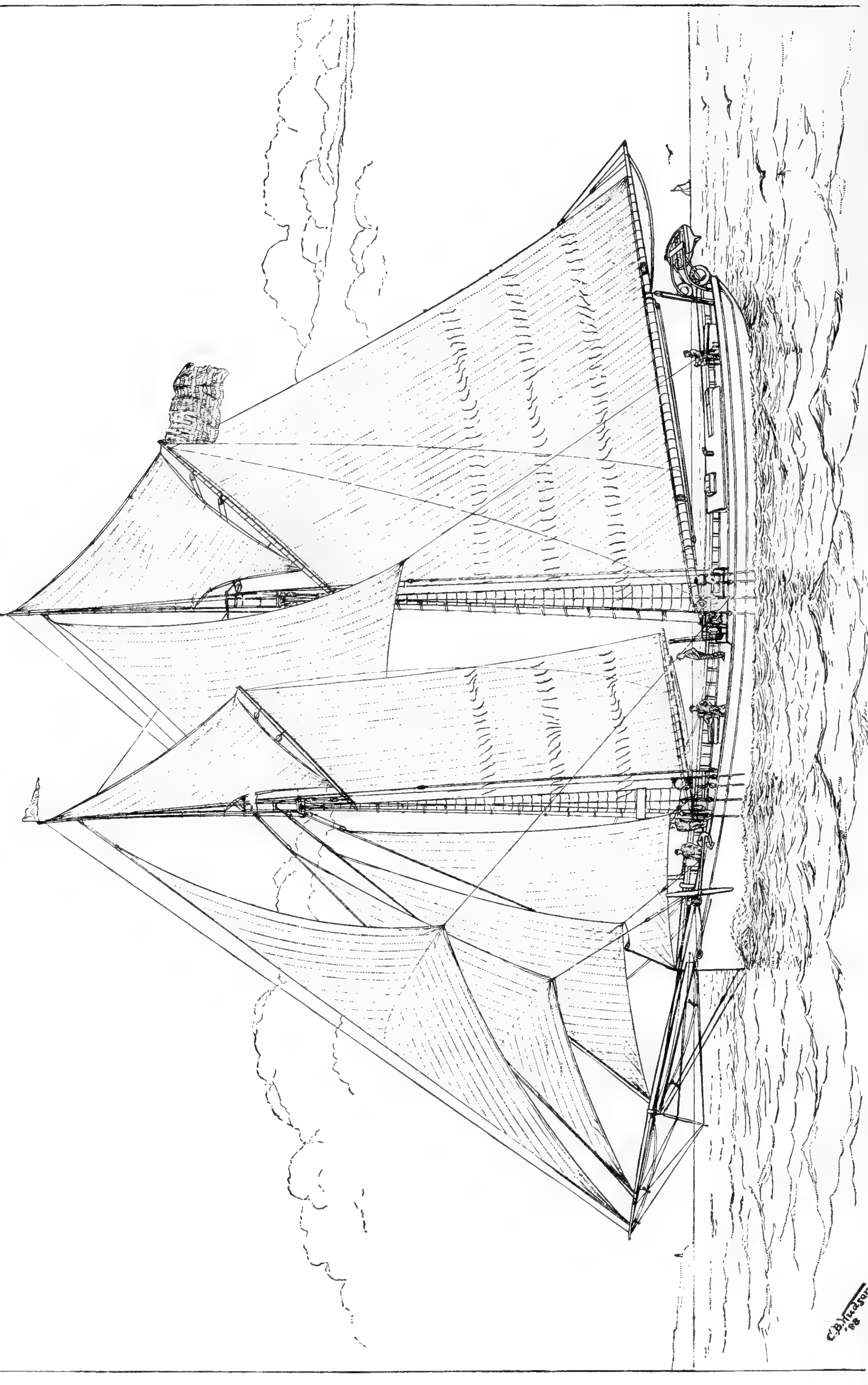
[NOTE.—The references are to page figures in brackets.]



THE GRAMPUS UNDER SAIL.

Drawn by C. B. Hudson.

5.—REPORT ON THE CONSTRUCTION AND EQUIPMENT OF THE SCHOONER GRAMPUS.

BY J. W. COLLINS.

A.—INTRODUCTORY NOTES.

The purposes for which the *Grampus* was constructed are various, and have an important bearing upon the work of the Commission. For some time previous to her construction it was felt that it was necessary to have a suitable sailing vessel provided with a well in which marine fishes could be kept alive and transported from the fishing grounds to the hatching stations on the coast, where the eggs might be obtained for the purpose of artificial propagation.

It could also serve a useful purpose by bringing in alive various marine species not, perhaps, in a gravid condition, which can be put into large aquaria, and thus afford to biologists the opportunity to study the habits of our ocean fauna under conditions that can not possibly be otherwise afforded.

It is also believed that a welled vessel, which is seaworthy and swift, will be able to visit European waters and bring therefrom alive to the United States certain marine species which do not occur in American waters, and which are held in high repute for food. The introduction and propagation of such fish as the sole, turbot, plaice, brill, etc., in our waters will doubtless be of great advantage to the United States, not only in giving to our people additional species of delicate food-fishes, but also in introducing for their capture the method of fishing with a beam-trawl, which is not at present in vogue here, and may, perhaps, profitably employ many vessels and men.

With the object of testing the practicability of using a beam-trawl in American waters in a commercial way, the *Grampus* was provided with a trawl such as is used in the fisheries of the North Sea, and certain modifications were made in her construction to fit her for operating it. While we have not the species of flat fishes which constitute the principal objects of the beam-trawl fishery in Europe, there are, nevertheless, several varieties in our waters that are nearly as good, and it is probable that in many localities on the sandy and muddy bottoms frequented by these off our coast the beam-trawl may be very effectively employed.

One of the most important works contemplated by the Commission is a comprehensive study of the movements of migratory fishes in the spring and autumn when they are approaching and leaving the feeding grounds frequented by them in summer. Hitherto less has been done in that special line of research than is desirable, owing chiefly to the fact that the Commission has not had at its disposal the requisite means for conducting so complete an investigation as seems to be necessary. In order to continuously follow the movements of the migratory species it is necessary to have a sailing vessel which is able to keep the sea in all weathers. Besides, having sails alone as a motive power, it is not dependent upon a supply of coal, and may, if necessary, remain at sea for weeks or months in succession.

An additional requisite for this work is to have a vessel which is adapted to and fit for carrying on fishing operations, and upon which various appliances and methods for the capture of fish can be used, in order that the presence of fish in any locality may be determined even when they do not come to the surface.

The *Grampus* is also fitted with appliances with which the various forms of minute life that constitute the food of most species of the migratory fishes can be obtained.

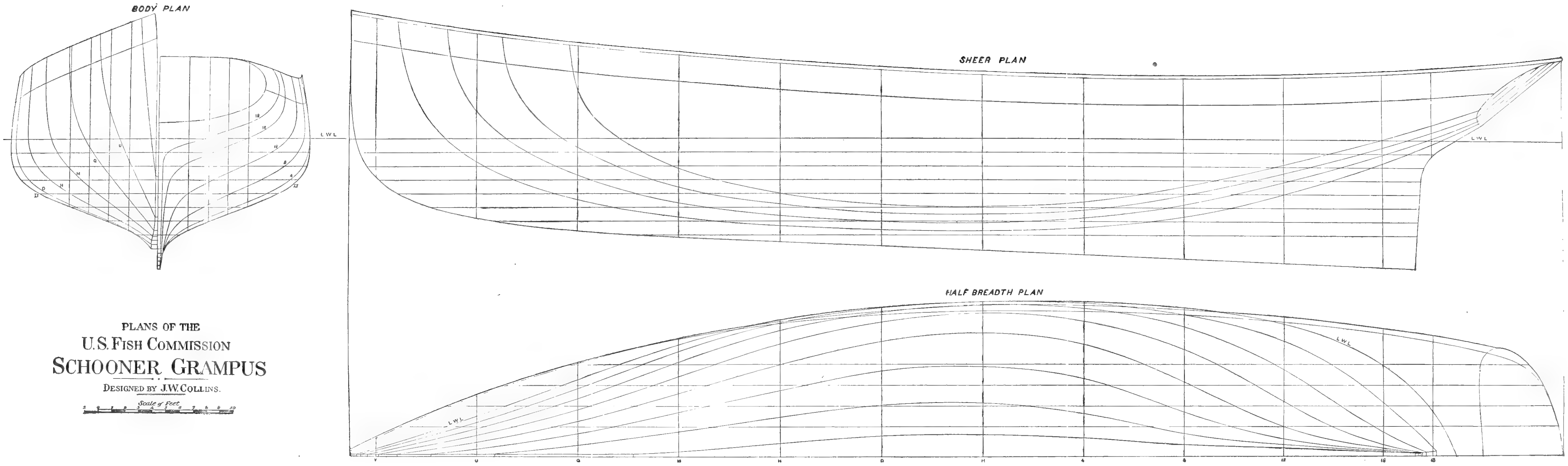
She is specially adapted to making researches at sea for the discovery and practical investigation of fishing grounds, as well as for collecting the fauna of the localities visited, and thus determining the value of certain regions for commercial fishing.

Perhaps the most important thing, however, in connection with the building of the *Grampus* was the opportunity afforded to attempt the introduction of new ideas in the construction of fishing vessels, both as relates to form and rig.

For many years previous to 1885, the tendency had been to build vessels employed in the ocean fisheries from New England wide, shallow and sharp, the object being to obtain speed and also considerable sail-carrying power, since it was believed the latter was necessary to produce a swift-sailing schooner. This form not only failed to produce the best results in the matter of speed, but it was highly dangerous, for when exposed to a gale a vessel constructed on such principles is liable to be capsized by heavy seas, and since her center of gravity is not sufficiently low to enable her to right again, the consequence has been that in such cases schooners have generally filled and sunk with all on board.

On many occasions the loss of life and property from this cause has been enormous, and the average for a period of years has been great. In the ten years from 1874 to 1883, inclusive, Gloucester alone lost eighty-two schooners that foundered at sea, of which seven were abandoned in a sinking condition. But on those never heard from eight hundred and ninety-five men were lost.

While an increase in the depth of these vessels was the most impor-



SHEER PLAN, HALF-BREADTH PLAN, AND BODY PLAN OF THE GRAMPUS.

tant object to be attained, there were, nevertheless, many other objectionable features besides shallowness in the typical clipper fishing schooner. Almost without exception, a vessel of that type was built very wide aft, with a heavy, clumsy stern and flat counters, the run being hollowed out excessively so as to produce in the after section a series of very abrupt horizontal curves, which are anything but desirable when speed is an object. It was also a universal custom to make the masts of a length that would insure their heads being nearly of the same height above the water-line, and to carry a large jib extending from the bowsprit end to the foremast. It is evident that both of these features are objectionable. When the masts are nearly of an equal length it follows, as a matter of course, that it is impracticable to give as much peak to the foresail as is desirable, providing the sail has all the hoist that the mast will permit. Thus, one of two things is the result; either the sails are unsymmetrical, from being too square on the head, or else the foremast is several feet longer than is actually necessary, and that much additional weight of spar is superfluous; besides increasing the cost it adds materially to the weight aloft and is a serious handicap upon the speed and stability of a vessel in strong winds and rough seas. A still greater objection can be urged against the practice of carrying a large jib. In the first place, when it becomes necessary to shorten sail, and the mainsail has to be reefed, it is almost invariably the case that the bonnet is taken out of the jib. In that event the center of effort of both the mainsail and jib is carried forward several feet, perhaps an average of seven to ten feet. The center of effort of the sails being carried so much in front of the normal position, the effect on the vessel is to prevent her from holding well to the wind, when sailing close-hauled, and to make it difficult for her to come in stays when under reefed sails. A more serious matter, however, is the fact that when the jib with the bonnet out can be no longer carried, and it is necessary to furl it, the sail can be handled only by men going on the bowsprit, and if the vessel is by the wind this duty must be performed at a great risk. Instances have not been uncommon when men were washed from the bowsprits of fishing schooners and drowned. It is, therefore, evident that both for safety of life and to improve the working qualities of a schooner, it is better to have a "double-head rig," since, having a fore staysail setting on a stay that comes to the knight heads or near it, the jib can be furled on the approach of rough weather, and there is no necessity for men to go upon the bowsprit in a gale, while it is thus possible to keep the center of effort of the sails in its proper position.

As early as the spring of 1882, the writer urged the desirability of improving both the model and rig of our fishing vessels, in a series of letters that were published in the Gloucester, Massachusetts, newspapers. These communications attracted considerable notice, and received the support of a number of intelligent men who were or had

been interested in the matter of building or running fishing vessels. Among these was James Davis, esq., judge of the police court at Gloucester, and formerly a builder of fishing vessels at that port.

However, although a slight change was made in some vessels to the extent of building them a few inches deeper, no decided innovation was made in the construction of fishing schooners until 1884. During the summer of that year, Mr. D. J. Lawler, at the suggestion of the writer, built the schooner *Roulette*, which was nearly 2 feet deeper than the ordinary fishing vessels of her length. She proved to be remarkably swift, as well as sea-worthy, though she still had the objectionable features of a heavy stern and rather flat counters.

In the spring of 1885, after my return from the cruise to the Gulf of Mexico in the steamer *Albatross*, Professor Baird instructed me to prepare the plans and specifications for a sailing schooner for the U. S. Fish Commission, for which Congress had made an appropriation of $14,000.

It had previously been determined that a schooner-rigged sailing vessel of about 80 tons net register would be best adapted to the requirements of the Commission.

The whole matter of designing her in all the details of model, rig, interior arrangement, and equipment, with the exception of the steam machinery and iron water-tanks, was placed in my hands.

The matter of determining what form of steam apparatus would be best adapted to the work of the new schooner was referred to Lieut.-Commander Z. L. Tanner, U. S. Navy, commanding the steamer *Albatross*. He decided that a steam windlass, with engines of 35 horse-power, would be the most suitable. Passed Assistant Engineer I. S. K. Reeves, U. S. Navy, consulting engineer of the Commission, had charge of obtaining and putting on board the steam boiler, steam pump, iron water-tanks, and such piping as was necessary for the operation of the steam apparatus, and to connect the water tanks.*

Owing to the fact that I had to make a trip on the *Albatross* during the summer of 1885, and also that other important work demanded my attention, the preparation of the plans and specifications for the *Grampus* was considerably delayed, and they were not finished until fall.

Acknowledgments are due to Mr. D. J. Lawler, of Chelsea, Massachusetts, for mechanical assistance he rendered in the preparation of the model and plans, and for the specially creditable manner in which he "laid down" the vessel and prepared her molds.†

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* The steam windlass, engines, and boiler were found on trial to be entirely too heavy and disproportionate to the size of the vessel, and in consequence they had to be removed. A wooden windlass was substituted; this relieved the schooner of a very considerable accumulation of weight forward and made her easier in a sea-way.

† The fact may properly be mentioned here that the model and lines of the *Grampus* were placed on exhibition at the rooms of the American Fish Bureau, at Gloucester, Massachusetts, in the autumn of 1885. They attracted much attention, so much indeed that they served as the basis for designing some new fishing vessels. One in

B.—CONSTRUCTION OF THE GRAMPUS.

1. SPECIAL FEATURES OF THE GRAMPUS.

The U. S. Fish Commission schooner *Grampus* is a wooden, two-masted, schooner-rigged, keel vessel. In general she resembles the typical fishing schooner of New England, from which she differs, however, in the following particulars:

First. She is about 2 feet deeper than the average schooner of the same length as usually built.

Second. Instead of having a raking stem and a long projecting head her stem is nearly straight and almost perpendicular above water, and below load-line curves away at an easy slope to join the keel.

Third. The stern is not so wide, and has much more rake.

Fourth. Instead of the run being excessively hollowed out, leaving the quarters and counters very flat, with abruptly curved horizontal lines, the after section of the *Grampus* approximates more closely to a V-shape in cross-section, and has much easier lines than the typical clipper schooner previously in use.*

Fifth. In having wire standing rigging fore and aft.

Sixth. In having the mainmast considerably longer than the foremast.

Seventh. In having a fore staysail and small jib instead of a large jib like that ordinarily carried by fishing vessels.

Eighth. In having the chain plates outside, and let into the wales so as to be nearly flush with the plank.

There are other minor points of difference, and some special arrangements, the latter having been adopted for the purpose of making the vessel adapted to the work she had to do, and which it is not necessary to specify in speaking of the points of difference between her and the clipper fishing schooner. The most noticeable of these peculiarities is the well, which is of the type ordinarily termed "box-well."

2. PARTIES WHO BUILT AND EQUIPPED THE VESSEL.

The hull (including the spars) was built at Noank, Connecticut, by Robert Palmer & Sons; the sails, rigging, blocks, and ground tackle were furnished by E. L. Rowe & Son, of Gloucester, Massachusetts;

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particular, the schooner *A. D. Story*, of Gloucester, was begun some weeks after the contract had been made for the *Grampus*, was completed, made a voyage to Newfoundland and back, and was about ready to start on a trip to Iceland for halibut when the *Grampus* was launched.

* The object in designing this form of hull was to obtain the maximum of seaworthiness, a considerable amount of carrying capacity, and as much speed as could be secured with a large midship section. In other words, to produce a safe, economical, all-around fishing vessel.

the boats were built by Higgins & Gifford, of the same port; the steam windlass was constructed by the American Ship Windlass Company, of Providence, Rhode Island; the boiler was obtained from M. V. B. Darling, of Providence, Rhode Island, and the remainder of the equipment was purchased chiefly from Bliss Brothers and H. M. Greenough, of Boston, Massachusetts.

3. DATE OF LAUNCHING, ETC.

She was launched on Tuesday, March 23, 1886, and went into commission on June 5, 1886.

4. DIMENSIONS.

Her general dimensions are as follows: Length over all, 90 feet; length on load water-line, 81 feet 6 inches; beam, extreme at deck, 22 feet 3 inches; beam at water-line, 22 feet 9 inches; depth from top of keel to top of main-deck beam, 11 feet 1 inch; height of quarter-deck, 9 inches; height of bulwarks, deck to top of rail, 26 inches; height of cabin-house, 27½ inches; length of cabin-house, 15 feet; width of cabin-house, forward end, 14 feet 7 inches; after end, 12 feet 6 inches; registered tonnage (net) 83.30 tons.

SPARS.*

Name.	Feet.	Inches.	Greatest diameter in inches.
Mainmast, deck to hounds	55	1	19
Mainmast head	7	6	....
Maintop-mast, above cap	28	6	9
Foremast, deck to hounds	52	11	19
Foremast head	8	....	....
Foretop-mast, above cap	26	....	9
Bowsprit, outside stem	19	....	†21
Jib-boom, outside of cap	17	3	9¼
Jib-boom, cap to flying-jib stay hole	11	6	....
Jib-boom, cap to balloon-jib stay hole	15	6	....
Main-boom	58	....	‡13
Main-gaff	28	6	§7¼
Fore-boom	23	10	7
Fore-gaff	24	....	6½
Swinging boat-booms, each	20	....	5

* The masts and bowsprit are made of white pine and all other spars were originally of spruce. In 1888 the main-boom was made of Oregon pine.

† The bowsprit is square between knight-heads, where its diameter is greatest. Outside of the stem it is rounded and tapers to a diameter of 15 inches at end.

‡ Main-boom made in 1888 was 59 feet long, 11¼ inches in diameter.

§ Main-gaff made in 1887 was 30 feet long.

INTERIOR ARRANGEMENT.

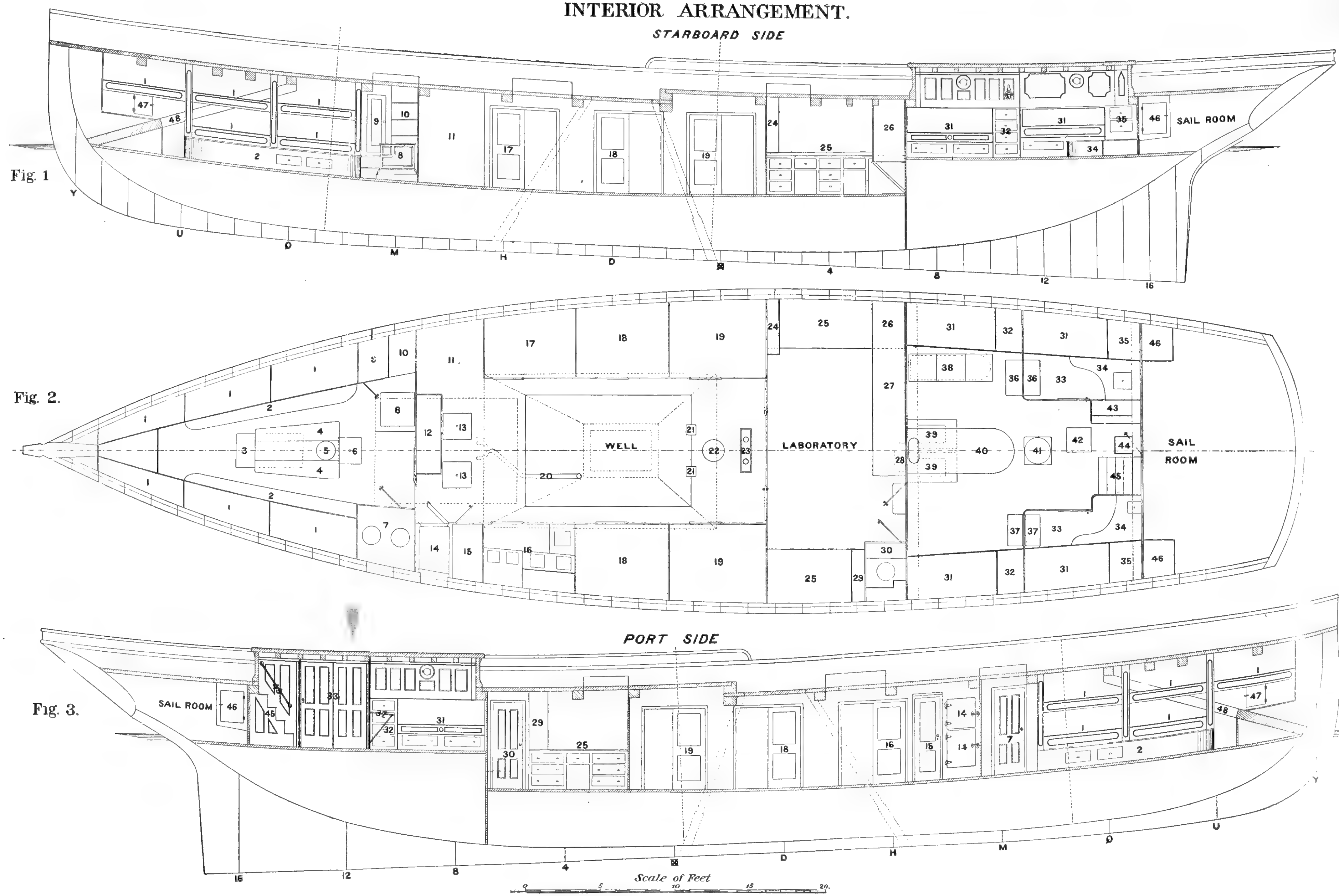

FIG. 1. Longitudinal sectional elevation, starboard side. FIG. 2. Plan of interior, under deck. FIG. 3. Longitudinal sectional elevation, port side.

Designed by J. W. Collins.

5. INDEX TO DETAILED PLANS OF GRAMPUS.*

(See plates III, IV, and XIV.)

1. Berths in the forecastle.
2. Locker seat.
3. Scuttle in forecastle floor.
4. Table.
5. Foremast.
6. Scuttle in floor aft of foremast.
7. Water-closet and lavatory.
8. Galley stove.
9. Dish closet.
10. Locker for cooking utensils.
11. Starboard side of fore-hold used for temporary stowage of small stores.
12. Chain lockers.
13. Scuttle or man-hole in water tank.
14. Refrigerator.
15. Grub-locker.
16. Store-room for provisions, and cook's pantry.
17. Coal pen.
18. Store-rooms for fishing apparatus, etc.
19. Bait and ice pens, frequently used for storage of fishery appliances.
20. Forward bilge pump.
21. Stanchions to main fife-rail.
22. Mainmast.
23. After bilge pumps.
24. Medicine closet.
25. Shelves.
26. Chest of drawers for spare bedding.
27. Sliding drawers, etc., for storage of collections.
28. Scuttle in floor leading to pipes connecting forward and after tanks.
29. Library closet.
30. Water-closet.
31. Berths.
32. Chests of drawers.
33. Floor of state-rooms.
34. Locker seats in state-rooms.
35. Drawers in state-rooms.
36. Writing-desks.
37. Adjustable or "drop" writing-tables.
38. Bath-tub.
39. Scuttle or man-hole in water tank.
40. Cabin mess-table.
41. Stove.
42. Scuttle in cabin floor leading to store-room.
43. China-lockers.
44. Binnacle.
45. Cabin steps or stairs.
46. Lockers in sail-room.
47. Locker underneath fore-peak berth.
48. Breast-hook.
49. Hand-rail to cabin stairs.
50. Forecastle step-ladder.
51. Step-ladder leading out of main-hatch.
52. Original pawl-bitt.
53. New pawl-bitt.
54. Windlass.
55. Fife-rail around foremast.
56. Main fife-rail.
57. Stanchions to forward fife-rail.
58. Forecastle companion.
59. Bowsprit.
60. Main-hatch with booby-hatch in position.
61. Entrance to well.
62. After-hatch with booby-hatch in position.
63. Cabin sky-light.
64. Cross section of sky-light.
65. Step-ladder leading from laboratory out of after hatch.
66. Laboratory lamp.
67. Sail-room.
68. Rudder-head.
69. Position of deck funnel for galley stove.
70. Andrew's ventilators.
71. Deck-lights.
72. Cabin stove-pipe.
73. Cabin companion.
74. Man-hole to sail-room.
75. Cavil stanchions.
76. Cook's table.
77. Jib-topsail or balloon jib.
78. Flying jib.
79. Jib.
80. Fore staysail.
81. Foresail.
82. Fore gaff-topsail.
83. Main staysail.
84. Mainsail (the dotted line shows form and dimensions of riding sail).
85. Main gaff-topsail (the full line shows size of club gaff-topsail, and the dotted line indicates the size of jib-header).

*The figures and letters shown on the keel of the plans indicate only the number of the frame against which they are placed, and the figures given in this list of explanations has no reference to those.

DETAILS OF CONSTRUCTION.

HULL.

Keel.—The keel of the *Grampus* is made of white oak; the main section running well forward and scarfing under the forward deadwood. It has only one scarf. It sides 15 inches in center and tapers to 9 inches at the deadwoods. The keel is molded 15 inches outside of garboard, and is curved to fit the shape of the hull. Bolted to the keel and forming part of it, is a shoe of white oak, molded 6 inches through the greater part of its length, tapering to 3 inches at its ends. The scarf of the keel and the shoe are bolted with 1-inch yellow-metal.

Stem.—The stem is made of white oak. It sides 12 inches at head, 9 inches at water-line, and also at heel where it joins dead-wood. It is bolted with 1-inch yellow-metal below water-line, and with galvanized iron above.

Stern-post.—The stern-post is of white oak, its lower end being a knee resting on after end of the keel, and firmly bolted to the latter with 1-inch yellow-metal bolts.

The stern-post, at the head above the rabbet, sides 16 inches; at the outer rabbet it is 12 inches, tapering to 9 inches at the heel. The after edge of the stern-post tapers from 12 inches at the port, where it is hollowed out to receive a 10-inch rudder-head, so that the hollow at the lower end will receive a 5-inch rudder-heel. It has a backing of white pine in the port, and the port is lined with heavy sheet lead.

Forward deadwood.—The apron piece of deadwood is white oak; it sides 12 inches at gunwale sheer and 9 inches at water-line, to conform to the dimensions of the stem, to which it is bolted with 1-inch bolts, yellow-metal being used below water-line and galvanized iron above.

The forward deadwood which comes over the scarf of the keel and stem is white oak, and sides 9 inches; the filling and lacing pieces of deadwood are hard pine, and are bolted with 1-inch galvanized iron.

After deadwood.—The lower piece of the after deadwood is oak, bolted with 1-inch yellow-metal. The upper or lacing pieces of deadwood are hard pine; siding 8 inches and bolted with 1-inch and 1⅛-inch galvanized iron, except where the bolts go into the stern-post, in which case yellow-metal is used.

Frames.—The frames are of white oak, grown to the mold, and spaced 22 inches from center to center. They are double to the gunwale, and arranged in the usual manner for the floors to break joints with the futtocks and so on, the frames being bolted together with ⅝-inch galvanized iron. The floor timbers side 8 inches, with the upper ends snapped to 6 inches; the futtocks side 6 inches and the top timbers or stanchions 5 inches. One of the latter is bolted to each frame, and has a quarter-round worked on its inner corners above deck. The frames mold 7½ inches at side of keel, 6 inches at second futtock head, and 5 inches at gunwale. In the throats of the flattest frames the floor timbers are 9 inches deep, but forward and aft the depth increases with the change in the shape.

In the well every other frame is omitted, and here the floors are worked with a quarter-round on their inside edges.

The floor timbers are bolted throughout with 1-inch yellow-metal bolts, which are driven through and clenched over composition rings on the bottom of the keel.

The stern frames are supported by "riders" of oak, which extend 4 or 5 feet up on the frames, and with the lower ends running down on the ceiling. These riders are strongly bolted to the ceiling and counter frames, as well as to the stern timbers.

Keelsons.—There is no keelson in the well, but there is one forward and one aft of it. These are made of hard pine, siding 10 inches, and are bolted to second-floor timbers with 1-inch yellow-metal; these bolts go through the keel, and were clenched over composition rings before the shoe was put on.

Breast-hook.—The breast-hook is of oak, backed by a hackmatack knee in its throat. It is strongly bolted with 1-inch and $\frac{3}{4}$-inch galvanized iron; the bolts are clenched over rings. It extends diagonally from below water-line to the deck.

Deck-frame.—The beams are of white oak; they side from 7 to 9 inches and mold 7 inches in center and 6 inches at the ends. The ends of the beams are bolted to the clamps with $\frac{7}{8}$-inch iron bolts. The ledges and carlines are of hard pine; they side $3\frac{1}{2}$ inches to 6 inches. The knees are of hackmatack; they side 5 inches. The mast-beds and partners are of hard pine, 10 inches thick, let down between beams 6 inches, and let in on edge of beams $1\frac{1}{2}$ inches. The edges which show above the deck-plank have one quarter-round worked on them all around, forming a raised panel on the deck. The windlass-bed, originally put into the spaces between the beams forward of the foremast, was of hard pine scantling, filled in flush with the beams and securely bolted to them. To this, on the underneath side, was secured the engine for operating the windlass.*

Pawl-bitt.—The original pawl-bitts are of white oak, each 8 inches by 8 inches, and 3 feet $6\frac{1}{2}$ inches high, separated so as to receive the heel of the bowsprit above the deck, and filled in above the bowsprit with white oak bolted through the bitts, coming to within about 10 inches of the top, above which the edges are rounded. An additional pawl-bitt 5 inches by 12 inches, backed on forward side by an oak piece 8 inches by 10 inches square on top, tapering to 6 inches by 4 inches at deck, was put in after the removal of the steam windlass. The bitt itself is about 19 inches abaft the other, while the backing piece is only 13 inches from it. There is an oak brace between the two 7 inches wide by 3 inches thick, rounded on upper side and placed 26 inches above deck.

* When the steam windlass was removed and the engine taken out, it was necessary, before putting in a wooden windlass, to remove this windlass-bed, and also to put in an additional beam to support the pawl-bitt for the wooden windlass, the position of which was about 19 inches abaft where the iron steam windlass was placed.

Fish-well.—The well of the *Grampus* is pyramidal in form, with the apex at the deck. It is 16 feet long in the clear at the bottom, and about 8 feet wide. At the top it is 4 feet long by $2\frac{1}{2}$ feet wide. It is what is termed a "box well," and has a bulkhead athwartships coming nearly to the surface of the water. The forward and after bulkheads extend from the bottom of the vessel flush with the top of the deck. The bulkheads are made of the best selected yellow oak, 7 inches thick. The lower plank in each bulkhead is canted and molded to fit the shape of the bottom on its lower edge, coming out flush with the outside planking, or made with "primings-out." It is rabbeted to receive the ends of the outside planks. The upper edge of the plank is level, and to this is bolted the succeeding plank. The ends of all the lower planks are flush with the outside planking up to the point where they join the "well-log" on each side. The bottom planks or floors have each two 1-inch yellow-metal bolts driven through them and the keel, and clenched over composition rings underneath the keel. The other well-planks are bolted edgewise with $\frac{3}{4}$-inch galvanized iron bolts, driven at distances of 14 inches from center to center, alternately, near the opposite edges of the plank. The planks on the sides of the well are so arranged that their edges come opposite the middle of the planks across the ends, so as to equalize the fastening in the corner posts. The planking of the well inside of the vessel is tongued and grooved on its edge, provided with a $\frac{1}{2}$-inch tongue of white pine in a groove 1 inch from inside of plank. Besides this, before the bolts were driven, a layer of calking cotton was placed in all of the seams between the well-plank. At the lower edge of the well, on each side, is what may be termed the *well-log.* This is of the best white oak; it sides 9 inches and is 21 inches deep. It comes out flush with the outer planking, being recessed to receive the frames which enter the well. The spaces over these frames are filled in, outside, with short pieces of plank, in the same manner as when the floor of an ordinary well is built with "primings-out." This well-log is fastened to the frames by $\frac{3}{4}$-inch yellow-metal bolts, which are headed outside of the timbers.

The floor frames in the well are fastened with 1-inch yellow-metal bolts going through them and the keel and clenched underneath the latter.

In each corner of the well is a white-oak post 7 inches square on two sides to fit into the corner, with one side half round. To this are fastened the ends of the well-planks, with $\frac{3}{4}$-inch galvanized iron screw-bolts set up on the outside with nuts.

A corner post or quarter round of hard pine is let in at the ends of the well-plank to flush the ends and sides of the well on the outside.

There are two hundred and four $2\frac{1}{2}$-inch holes in the outside planking covering the bottom of the well, to permit the water to circulate freely. After these holes were bored they were all burned with a red-hot iron.*

* In December, 1887, the well was coppered inside to a foot above the water-line, and "sleeves" were worked into the holes from the outside, thus making them somewhat smaller.

CONSTRUCTION PLANS.

Fig. 1.

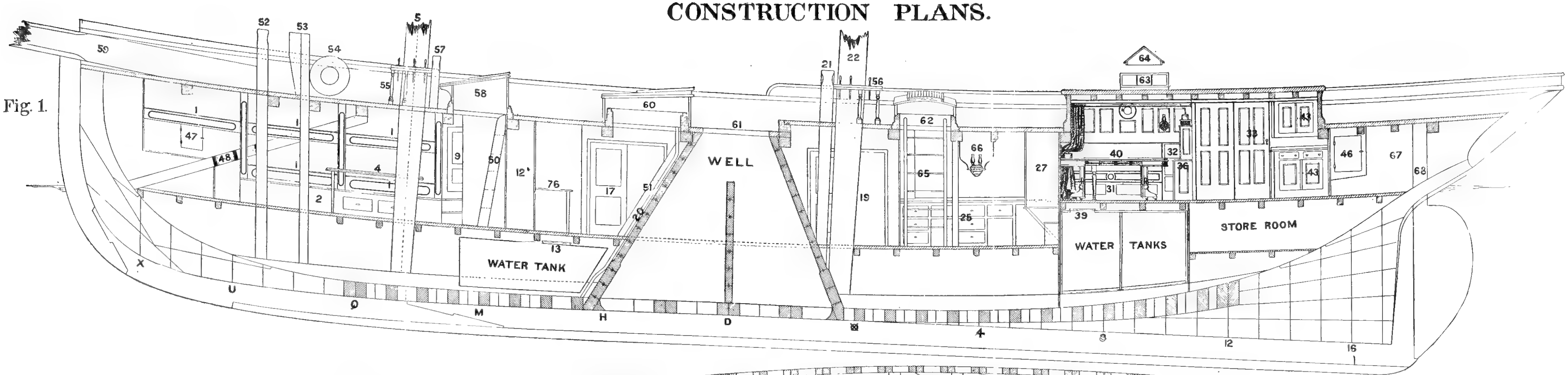

Fig. 2.

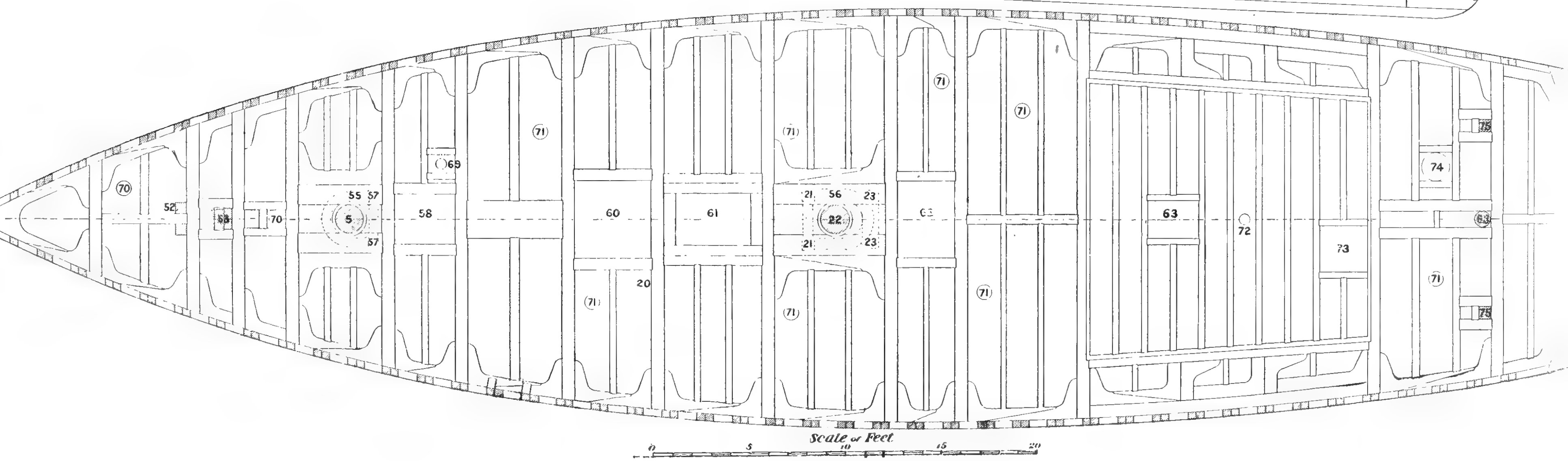

FIG. 1. Longitudinal sectional elevation, showing framing.

FIG. 2. Plan showing deck frame, etc.

Designed by J. W. Collins.

Ceiling.—The ceiling is of hard pine, and most of it was put on before the vessel was planked. There are two thick streaks alongside of the well-log, each of which is 6 inches thick by 9 inches wide, tapering to equal 3 inches in thickness at forward and after ends. These thick streaks are fastened with $\frac{3}{4}$-inch galvanized iron bolts, one bolt in each edge driven through the frames and clenched on galvanized iron rings. There are also, besides these, five thick streaks on each side which are 4 inches thick by 12 inches wide, tapering at the ends to $2\frac{1}{2}$ inches thick, and fastened with galvanized iron bolts, half of which are driven from the face of the plank and the other half from the outside of frame, all clenched over galvanized iron rings.* There are two streaks of $3\frac{1}{2}$ by 9 inch plank tapering to 2 inches at the ends, and three streaks of 3-inch plank, the latter fastened with galvanized-iron bolts and spikes.

The clamps are, like the rest of the ceiling, hard pine, $3\frac{1}{2}$ inches thick and 12 inches wide. They are joined with lock scarf, and fastened like the other ceiling. There is a bead worked on the lower edge.†

Deck plank.—The deck plank are white pine 3 inches square, laid straight, fastened with $4\frac{1}{2}$-inch galvanized iron spikes let into the plank and covered by bungs set in white lead.

The plankshear is white oak, 3 inches thick, by $10\frac{1}{2}$ wide, fastened to the wales with $\frac{3}{4}$-inch galvanized iron bolts and with a $\frac{1}{2}$-inch galvanized iron bolt driven into the back of each stanchion.

Outside planking.—The outside planking is of white oak. The garboards are each 8 inches wide and 4 inches thick, tapering from each end of well to equal 2 inches in thickness at the wood ends to conform to the thickness of the rabbet at forefoot, and at the heel of sternpost. In addition to the ordinary fastening, the garboards are edge-bolted to the keel with $\frac{5}{8}$-inch yellow-metal bolts.‡

The bottom plank are $2\frac{1}{2}$ inches thick, and fastened with 6-inch composition spikes in addition to the locust treenails which go through all the plank and are $1\frac{1}{8}$ inches in diameter. All the bottom plank are

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* Besides the fastening specialized in this description, note should be made of the fact that the treenails which are driven in the outside planking come through to inside of ceiling, and are wedged on each end.

† A peculiarity of the ceiling is that the thick streaks sweep up from the bilge at each end of the vessel, crossing the direction of the outside plank diagonally. This method of putting on the ceiling adds very much to the strength of the vessel at the ends.

‡ This peculiarity of construction adds little to the expense; it increases very materially the strength of a vessel, and the chances of being saved in case she had the misfortune to get on shore. It ties the garboards to the keel in such a manner that the keel, keelson and garboards combine together to form one continuous backbone. Ordinarily, when a vessel is stranded, the greatest strain comes upon the garboard or the keel, and if not built in this way, either the keel is twisted out of position or the garboard is strained so as to work the oakum out of the seams, the result in each case being that she fills with water, and the chances of her safety are decreased. I earnestly recommend this peculiarity of construction to be adopted in building fishing vessels.

"square fastened," having four treenails in a frame, while the other plank have two treenails and one spike to each frame.

The wales are 3 inches thick and 6 inches wide, and there are four streaks of the same thickness below the wales. The wales are fastened with 6-inch galvanized spikes, and with treenails, like the rest of the plank, but below the fifth wale the plank are fastened, in addition to treenails, with 6-inch composition spikes, which are let in, and the heads are covered with bungs set in white lead. All butts below the sixth wale are fastened with $\frac{3}{4}$-inch copper butt-bolts, driven and clenched on composition rings on the inside of the ceiling.

Main-rails.—The main-rails are of white oak, 3 inches thick and 9 inches wide, fayed with lock scarf, and worked with a double bead on each edge; they are bolted to the stanchions with $\frac{3}{4}$-inch copper bolts let into the rail, and the heads covered with bungs set in white lead.

Monkey rail.—The monkey-rail, or quarter-rail, which rests upon the main-rail in the after section of the vessel, is 9 inches high. The rail proper is of white oak, $2\frac{1}{4}$ inches thick and 6 inches wide, worked with a double bead on each edge.

The "filling-in piece" of the monkey rail is hard pine, 4 inches thick on the lower edge, tapering to 3 inches thick on the upper edge, with the exception of that portion which goes around the stern forming a part of the taffrail, which is made of white oak, increasing in thickness to the midship line to receive the mortise for the main-boom crutch.

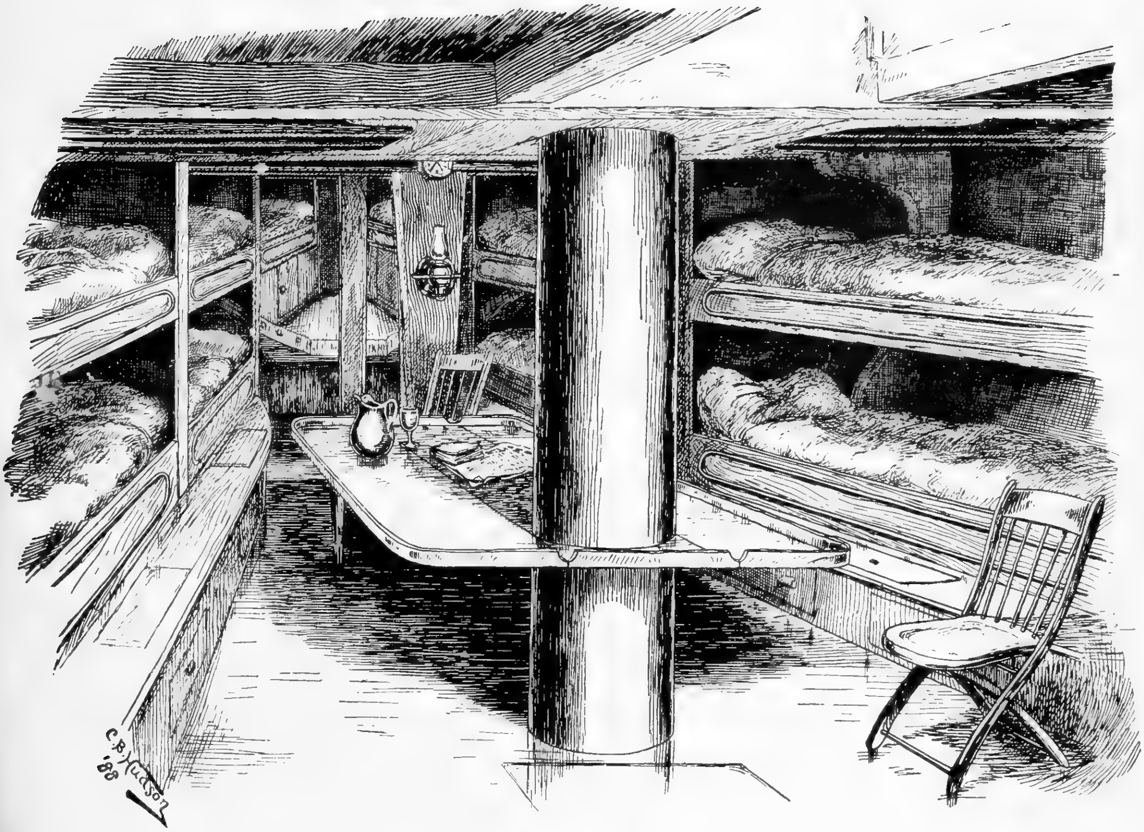
The fastening is $\frac{3}{4}$-inch copper bolts, going through into the heads of the top timbers or stanchions. The bolts are let into the rail and covered with bungs set in white lead. In the main and quarter rails are holes fitted with appropriate galvanized-iron castings to receive awning stanchions.

Bulwarks.—The bulwarks are of 1-inch white pine, beaded 3 inches apart, and extending from the main rail down to the covering board on the quarter, and on the main-deck to the waist-plank, which is 9 inches high. There is a water-port in the bulwarks on each side of the quarter-deck, just forward of the house; this is 21 inches long by 9 inches wide.

Bow-chocks.—The bow-chocks, which extend from the fore rigging to the knight-heads on top of the main-rail, are of oak, 5 inches high at the forward end and $2\frac{1}{2}$ inches at the after end, molded 4 inches at bottom and $3\frac{1}{2}$ inches at top; bolted to main-rail with $\frac{5}{8}$ and $\frac{3}{4}$-inch bolts, the fastening covered with bungs set in white lead.

Cat-heads.—The cat-heads are white oak, worked knee shape, and grown to mold; they extend outboard 20 inches, are fitted with a sheave hole in the outer ends, are provided with an iron brace on the after side extending to the main-rail, and eyebolts on the forward side for the jib-boom guys to set up to. They are bolted to a top timber on each side of the bow, 11 feet forward of the fore rigging.

Bow-grating.—The main-rail forward, about 6 feet abaft the knight-



FORECASTLE, LOOKING FORWARD.

Drawn by C. B. Hudson.

heads, is carried around in a semi-circle on the after side, from one rail to the other, over the heel of the bowsprit, and between this and the extreme bow is fitted in an adjustable triangular-shaped white oak grating covering the forward part of the heel of the bowsprit.

Rudder.—The rudder is made of oak and pine; the front and back of it being of oak. It is hung with three sets of best quality composition braces.

Fife-rails.—There is a fife-rail around each mast, in form something like those ordinarily put on fishing schooners. The fife-rail around the foremast has the bitts, which are 6 inches square, on the after side of the mast, and the rail, which sets upon stanchions, curves around the forward side of the mast; a straight piece of rail extends from one stanchion to the other abaft the mast. There are bolts going through the stanchions and rail, and these are set up by a nut underneath the beams and mast bed.

The bitts of the main fife-rail are 9 inches square and extend down through the deck until they reach the after side of the well. The heel of each bitt is chamferred to fit the angle of the well, to which it is bolted with $\frac{3}{4}$-inch galvanized iron bolts; it is also securely fastened to the deck-frame. These bitts stand forward of the mast on each side of it, and are made and fastened in the manner specified in order that they will sustain a heavy strain, since it is expected that the towing line of the beam trawl will be fastened to them. A rail extends from one bitt to the other in front of the mast, and another curves around abaft the mast, and is supported by several stanchions, which are fastened in the same manner as indicated in the description of the forward fife-rail. The rail, stanchions, and bitts are made of white oak.

Coamings.—The hatch-coamings are of the best quality of white oak, 5 inches thick, and worked with proper moldings all around. The upper edges of the coamings are rabbeted so as to receive skylights or booby-hatches. The coamings are bolted to the beams with $\frac{3}{4}$-inch galvanized iron, clenched underneath the beams over galvanized iron rings.

Booby-hatches.—There is a booby-hatch made to fit over the main-hatch; it rests upon the deck with an entrance on its after end. It is built of white pine 2-inch plank, side and ends, and covered with lighter material. It is held in place by stout galvanized iron hasps on the inside, which hook into staples on the hatch-coamings, and also by rope lashings through ringbolts in the ends of the booby-hatch and on the deck.

There is a booby-hatch over the after-hatch, built in a similar manner, with the opening on the starboard side, and constructed to fit down over a rabbet in the hatch coaming. It is held in place by hasps inside and metal plates screwed to the outside.

Cabin-house or trunk.—The house or cabin-trunk is 15 feet long, 14 feet 7 inches wide on forward end, 12 feet 6 inches wide at after end, and $27\frac{1}{2}$ inches high. The coamings are hard pine, 5 inches thick and

6 inches high above deck, worked with a molding. The sides and ends are made with 3-inch white pine plank fastened to posts at the corners, and with a quarter-round post at each corner on the outside to flush the plank. It is fastened to the beams with $\frac{5}{8}$ to $\frac{3}{4}$ inch bolts. Those of the after end and starboard side are of yellow metal or copper, the rest being galvanized iron. The top of the trunk is covered with 3 by 3-inch clear white pine plank, fastened with composition spikes $4\frac{1}{2}$ inches long; the latter are covered with bungs set in white lead. The beams are of hard pine spaced 18 inches, from center to center; the ends are bolted to sides of house with $\frac{5}{8}$-inch yellow-metal bolts. There is a mahogany skylight on top of trunk 3 feet long by 2 feet wide. The companion or cabin entrance is on the after end, at the port side; it is fitted with swinging doors and sliding top.

Forecastle companion.—The forecastle companion is located immediately abaft the foremast. It is built of white pine on a coaming of white oak, provided with a slide-cover like the booby-hatches, and with an adjustable door sliding in vertical grooves; it opens on the after end.

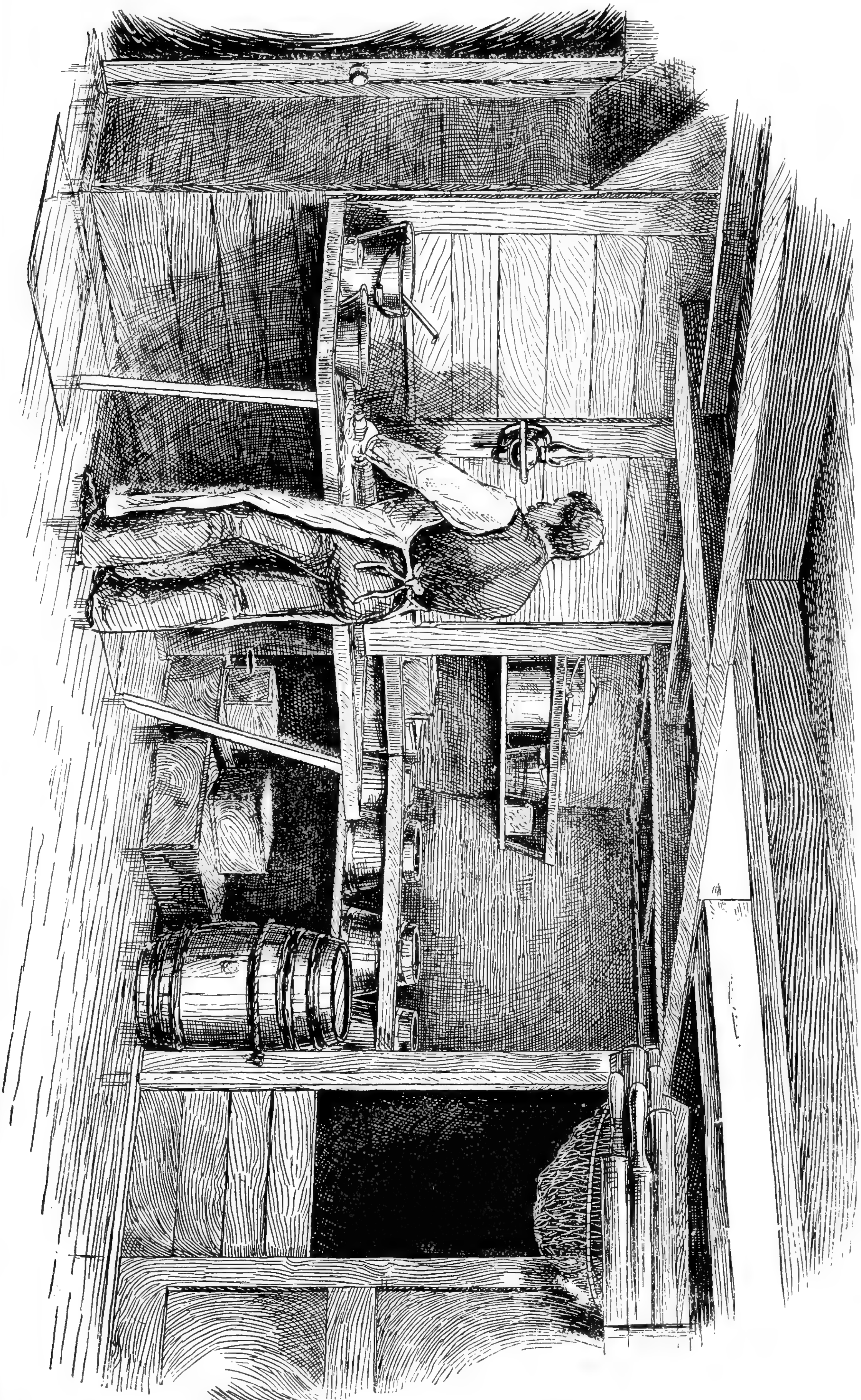
Wheel-box.—The wheel-box is built of ash and black walnut, paneled on the sides and ends. The top or cover is adjustable, made quarter-round on the sides, and fitted with hasps for holding it in place. The box is oblong in form, 3 feet 4 inches long by 2 feet wide; 2 feet 8 inches high on forward end, 2 feet 2 inches high on after end. There is a slot cut in the forward end to allow the telltale, indicating the position of the rudder, to work in.

Cavil-chocks.—There is a cavil-chock on each side abaft the house, on frames 17 and 18. It is made of oak, securely bolted to the stanchions at each end, and has a panel worked on its inside, with a 3 by 5-inch hole in it for receiving mooring hawsers, etc.

A similar cavil is placed on each side on frames A and B at the forward end of quarter-deck. A small cavil, $3\frac{1}{2}$ inches wide by 2 inches thick, is fastened on each side to stanchions of frames G and H on main deck, 7 and 8 and 13 and 14 on quarter-deck.

Stanchion cavils.—There are two oak stanchions, with cross-cavils, abaft the cabin-trunk, one on each side, for belaying the main sheet to; these go through the deck, and their lower ends are bolted to the frames.

Pin-rails, cleats, etc.—There is a pin-rail of oak fastened to the main-rail on each side abreast of the main rigging, and holes are bored for pins in the main-rail on each side abreast of the fore rigging. There is a snatch cleat, provided with sheaves, on each bitt of the fore and main fife-rails; also on the stanchion abreast of starboard fore rigging; three cleats on each side forward for the head sheets, and a stout oak cleat for the fore sheet on the forward side of the cross-bar to the main fife-rail, which is a little above the deck. On each side of the stern, about 8 inches above deck, is a cleat to which the crutch-tackles are fastened. Besides these, there are the davit-tackle cleats on the quarter-rail near the davits; the necessary cleats, with sheaves, to the



FOREHOLD, LOOKING TO STARBOARD.

Drawn by C. B. Hudson.

gaffs for the gaff-topsail sheets, and cleats on the main-boom for belaying reef-tackle, boom tackle, and toppinglift-fall to.

Crutches.—There is a white oak crutch, to receive the end of the fore-boom, which steps into the forward side of the main fife-rail; it is 4 feet 9 inches long and 9 inches wide at the upper end, tapering to lower end as required. There is a white oak crutch for the main-boom to rest in which steps into the taffrail; it is 4 feet 5 inches long, exclusive of that part which enters the taffrail, which is 6 inches long. The crutch is 15 inches wide at the upper end tapering to 11 inches, where it rests upon the taffrail, and below which it is formed to fit into the socket that receives it. Both of these crutches are concaved at the upper ends, or worked out with a half-round of the proper size to receive the boom they are intended for; they have a bolt going through them at the upper and lower ends to prevent splitting.

Hatches.—The hatches (properly speaking) or hatch coverings, are made in two parts for each hatch; they are made of 2½-inch pine and oak fastened to 2½ by 2½-inch carlines of oak. Galvanized iron ring-bolts are fastened into the corners.*

Deck-lights and ventilators.—There are eight circular deck-lights, 9 inches in diameter by 1½ inches thick, let into the deck and set tightly in white lead, held in place by composition rings screwed to deck. There are two gun-metal Andrews's ventilator deck-lights forward, for ventilating the forecastle; one of these is located forward of the windlass on the starboard side, and the other abaft the windlass amidships.

Sail-room man-hole.—Abaft the house, on the starboard side, is the man-hole leading into the sail-room. The cover, and the rim into which it fits, are of brass, and the cover is provided with a special locking arrangement, which secures it firmly in place. There is, in addition, an open scroll-work brass cover for the man-hole, which can be put on in dry weather for ventilating the sail-room.

Well-grating.—The top of the well opening, or "curb," is provided with an oak grating which fits on flush with the deck, and is held in place by a galvanized iron bar, 2 inches wide, properly secured at the ends by means of staples.

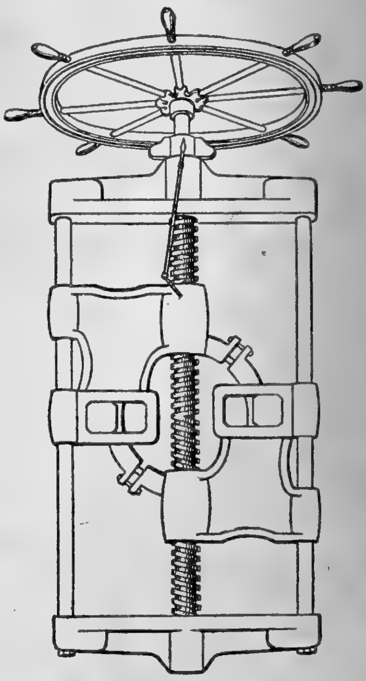


FIG. 1.—Steering wheel.

Steering wheel.—The steering wheel is the Richardson challenge steerer. It is of the right and left screw pattern in common use on small vessels.

* Under ordinary circumstances the hatches are not used, the booby-hatches supplying their places, but they are always kept ready for an emergency, so that in case one of the booby-hatches should be stove they can be instantly put on to prevent water from getting into the hold. Sometimes, in a gale, the main-hatches are put on and secured by the hatch bar underneath the booby-hatch.

Sheet-buffers.—The lower fore- and main-sheet blocks are provided with patent rubber buffers to ease the jerk of the sheets.

Calking.—The vessel was calked on the outside with three threads of the best oakum in each seam. The house was calked with cotton, and the deck and ceiling were calked with two and three threads of oakum. All the seams were pitched or white-leaded. In addition, the outside seams were puttied flush with the plank.

Cementing and salting.—The spaces between the frames (except in the fish-well) are filled flush with Portland cement as high as the underneath sides of the floors of the hold, and after this was done all the spaces between the timbers were filled with salt to the deck.

Ballast.—The ballast is pig-iron, stowed alongside of and abaft of the well, as far aft as the forward bulkhead of the cabin; leaving, however, sufficient space next the floor for operating the cocks on the pipes which connect the water-tanks. She carries about 40 tons of ballast, including the cement between the frames previously referred to.

Pumps.—There are two patent iron pumps abaft the mainmast, and one copper pump forward of the well. The latter is provided with an adjustable upper box that can be removed when not in use, and with a screw top which fits in flush with the deck. From the lower end of the copper cylinder, forming the chamber of the pump, a 3-inch lead pipe (cased with wood above the floor of the hold) extends down to the keelson where it is divided into two parts, one of which goes on each side of the keelson, so that both bilges can be pumped dry.

Beam-trawl roller.—Aft of the fore rigging, on the port side, is an iron roller for the beam-trawl warp to run over, fitted in between two stanchions. The main-rail is cut over this roller, and arranged on hinges so that it may be turned back when the roller is in use. A section of bulwarks is also made so that it can be removed.

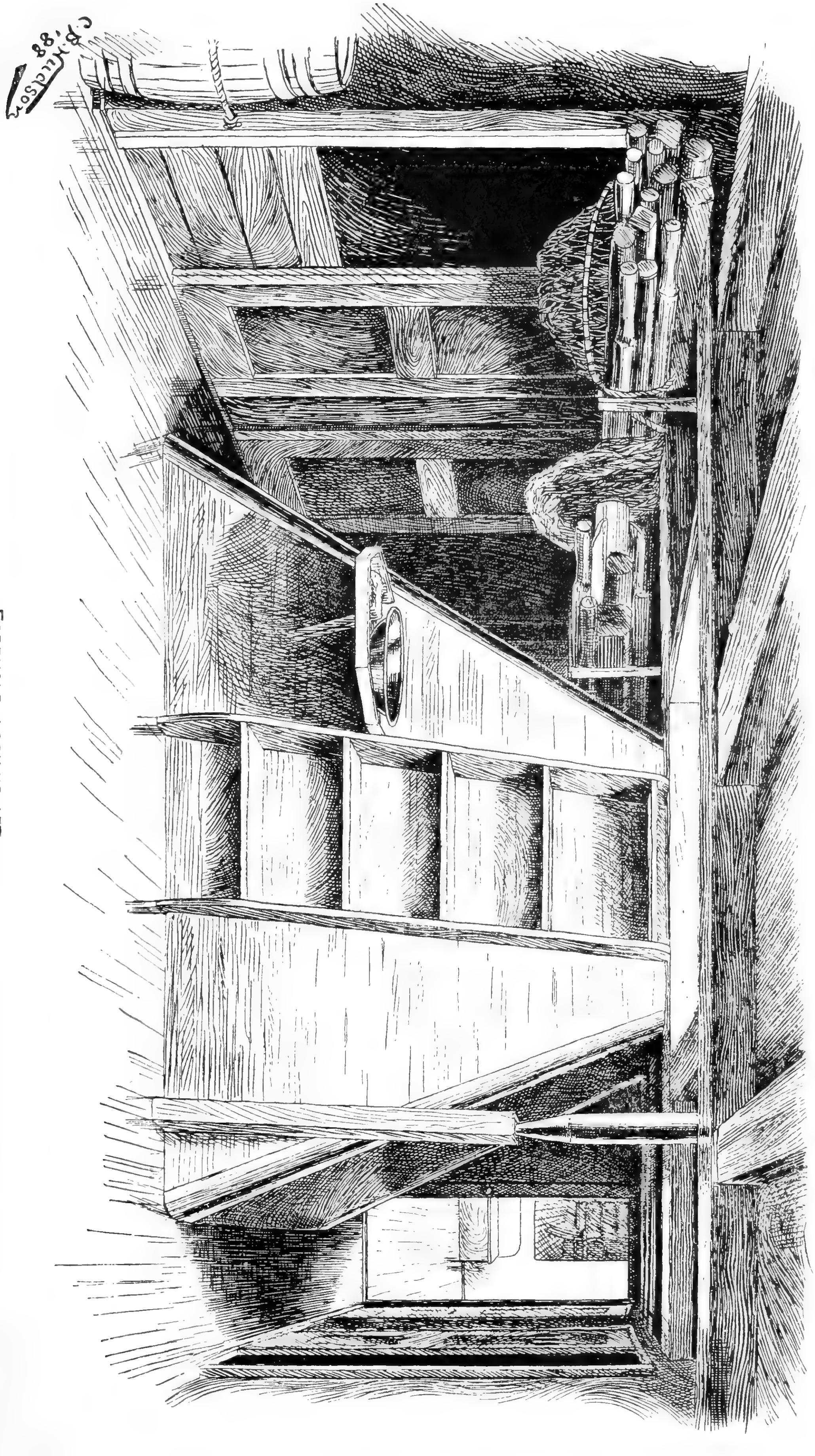
Iron warping-chocks.—On each side of the taffrail is let in and fastened a galvanized iron warping-chock of the ordinary pattern, and a similar chock is fastened to the top of each bow-chock near the knightheads.

Davits.—The davits are made of galvanized wrought iron, 3 inches in diameter, bent to a proper curve, fitted with suitable braces, and each provided with a block at outer end to receive davit-tackle fall.

Hawse-pipes.—The hawse-pipes are made of galvanized cast-iron, cast to a special mold to fit the vessel.

Chain pipes.—The chain-pipes, of galvanized iron, are placed abaft the forecastle companion, about 5 inches diagonally from the after corners; the chain hawsers lead through these into the boxes below. They are 5 inches diameter inside.*

* As the vessel was originally constructed, there were pipes leading from beneath the windlass to the space underneath the forecastle floor, where the chains were at first stowed, while the steam windlass was on board. When the steam windlass was removed and a wooden windlass put on, a box was built to receive the chains abaft the forecastle bulk-head, and the location of the chain pipes was changed.



FOREHOLD, LOOKING AFT.

Drawn by C B Hudson

Anchor plates.—On each side of the bow, near the water line, and directly beneath the cat-head, is a thick metal plate, about 3 feet square, to prevent the bill of the anchor from injuring the plank when the former is being catted in rough water.*

Iron guards.—On each side of the bow-chocks, forward of the fore rigging, there are galvanized iron guards for the anchor bills to rest upon. There is also a galvanized iron guard of half-round iron, $1\frac{1}{4}$ inches wide, on the after edge of the taffrail, to prevent the rail from being chafed by lines or boat painters.

Chain-plates.—There are three chain-plates on each side, abreast of each mast, for the shrouds, made of galvanized Norway iron, 3 inches wide by $\frac{9}{16}$ inch thick, chamferred slightly at the edges. These are let into the wales nearly flush, and are bolted through wales and ceiling with 1 and $1\frac{1}{8}$-inch galvanized iron bolts; these are keyed over rings on the inside of the ceiling. There is also a similar chain-plate, not quite so wide, on each side of each mast abaft the others, for the topmast backstay.

Ring-bolts and eye-bolts.—On each side of the stern, inside near the deck, there is a 1-inch galvanized iron ring-bolt for crutch tackles, and on top of the taffrail, on each side, is a ring-bolt of $\frac{5}{8}$-inch galvanized iron for the boat-gripe lashings. On stanchions D, F, O, 5, and 12 there are ring-bolts of $\frac{5}{8}$-inch galvanized iron, the diameter of the ring being 4 inches; those on stanchions O and P, forward of the fore rigging, are for lashing the bill of the anchor to on each side, and for other necessary purposes.

There are also two similar ring-bolts on port side of the main deck, near the main-hatch, and four on starboard side to lash boats to, and smaller ones forward and aft of main-hatch to lash the booby-hatch to. On each side, outside of the stern, is a stout galvanized iron eye-bolt for the boat-gripe to hook into. There is a ring of $\frac{3}{4}$-inch iron in after end of the bolt which holds each of the after lower dead-eyes for the fore and main rigging. On each side, in the forward side of the grub beam, there is a $\frac{7}{8}$-inch galvanized iron bolt for hooking in a tackle to keep the foreboom steady when jibing in a gale, etc. On each side, forward of the main-hatch, there is a $1\frac{1}{4}$-inch galvanized iron eye-bolt which goes through deck and beam, and keys over ring underneath the beam. This is for the purpose of hooking to it a heavy snatch block through which the beam trawl warp or other similar line may run. Aft of the cat-head, on each side, is a $\frac{3}{4}$-inch galvanized iron bolt worked onto a plate, which is fastened to the outside edge of the main-rail, for the fore-boom tackle to hook into. There is a similar eye-bolt of $\frac{7}{8}$-inch iron on each side forward of the cat-head for the inner dead-eye of the martin-

* When the vessel was new the plates used were made of galvanized wrought-iron, but at the time she was coppered in the winter of 1887, the iron plates were taken off and plates of yellow-metal substituted.

gale back-rope to shackle to, and another of 1-inch iron on each side on the wale below the cat-head, for the bowsprit shrouds to fasten to. Besides these, there is a $\frac{5}{8}$-inch eye-bolt driven from outside, into stanchion P, 19 inches below rail, to lash outer bill of anchor to; also on each side, near the forward end of the bow chock, a $\frac{1}{2}$-inch eye-bolt for the inner end of the life-line (which goes from the bowsprit end to the bow) to fasten to. There are two $\frac{7}{8}$-inch eye-bolts on the forward side of each cat-head for the jib-boom guys to set up to; these go through and head up on after side of cat-head. Aft of the fore and main rigging, on the port side, is a $\frac{5}{8}$-inch eye-bolt for the lower block of the peak-whips to hook into. Aft of the fore and main rigging, on each side, is a $\frac{7}{8}$-inch U-shaped bolt for the boom-tackle to hook into; those forward go through the main-rail and key underneath, the others drive into the quarter-rail. On the starboard side, aft of main rigging and boom-tackle bolt, is a $\frac{5}{8}$-inch eye-bolt in rail. On top of the bow chock, on each side, are two $\frac{3}{4}$-inch eye-bolts for the jib and flying jib sheets to hook into; these are located, respectively, 5 feet and 10 inches from the cat-head.

On each side, abreast of frames K and L, respectively, and 21 inches inboard from the stanchions, there are two 1-inch eye-bolts driven into the deck (going into beam and carline), for the lower fore staysail-sheet blocks to fasten to.

On the main-rail, inside and abreast of the lower forward dead-eye of fore-rigging, on each side, is a $\frac{5}{8}$-inch eye-bolt, into which the fore staysail lift or tackles can be hooked. There is a similar eye-bolt on each side, on the fore and main fife-rails.

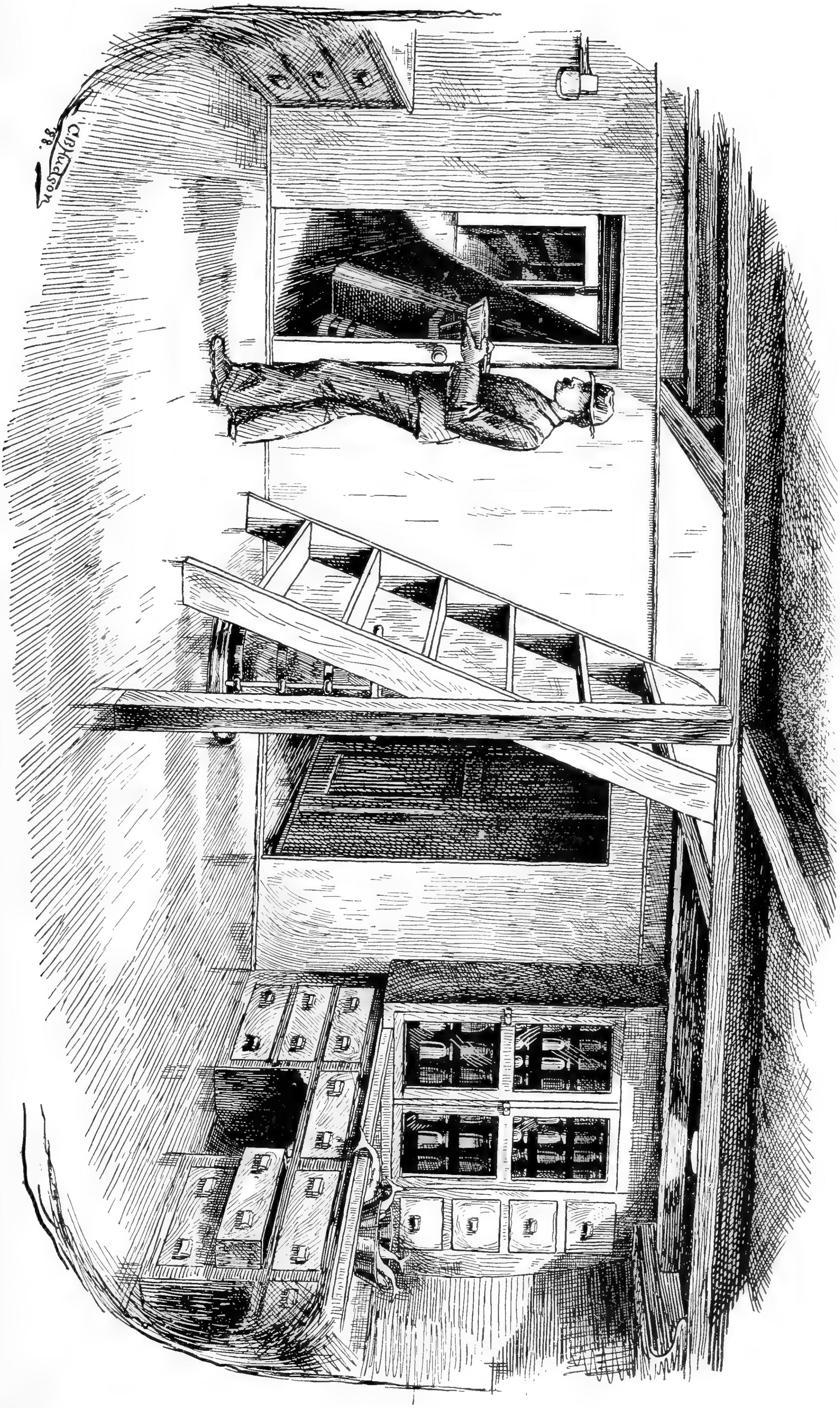
Bobstay and jib-stay plates.—The bobstay and jib-stay plates are galvanized Norway iron, 3 inches wide by $\frac{3}{4}$ inches thick, let into the plank and stem, and extending back onto the plank, riveted through with 1-inch galvanized iron bolts. Galvanized iron rods each 3 feet long and $1\frac{1}{4}$ to $1\frac{1}{2}$ inches diameter are held to the plates with bolts, and extend forward to receive the ends of bobstay and jib-stay, the end of the former being held by a bolt and the latter setting up on end over a roller-thimble in the end of the rod.

Gammon-strap.—The gammon-strap is of galvanized Norway iron, $3\frac{3}{4}$ inches wide and $\frac{3}{4}$-inch thick; fitted at the top to receive the iron thimble over which the forestay sets up.

Saddle-band.—The saddle-bands on the masts are of galvanized iron, $2\frac{1}{2}$ to 3 inches wide and from $\frac{1}{2}$ to $\frac{3}{4}$ inches thick.

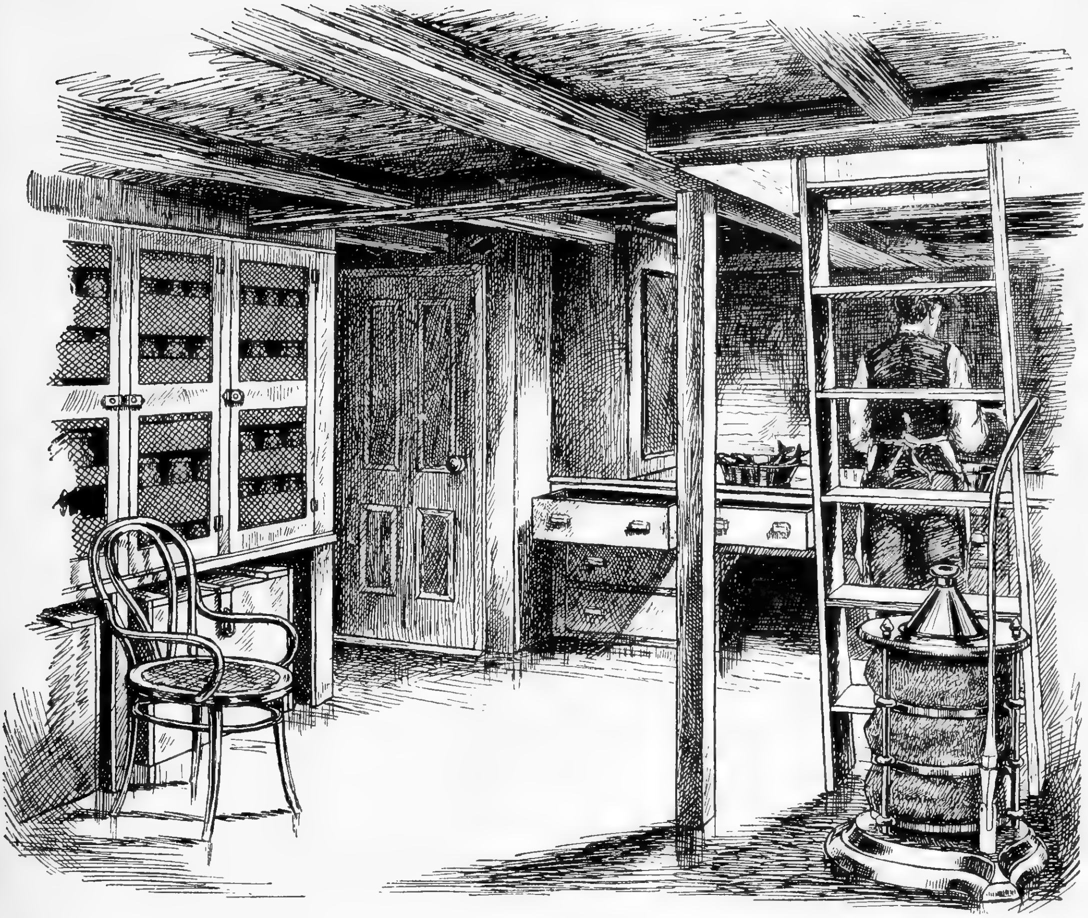
Jib-boom guy outrigger.—The jib-boom guy outrigger, which extends and supports the jib-boom guys, is made of galvanized iron of a special pattern, in one piece, 7 feet 4 inches long, $1\frac{1}{2}$ inches average diameter. It is fastened by screw-bolts to a band crossing the end of the bowsprit.

Martingale.—The martingale is made of oak, 5 feet long, 4 inches in diameter, and is provided with the necessary galvanized iron hooks, bands, eyes, etc.



LABORATORY, LOOKING FORWARD.

Drawn by C. B. Hudson.



LABORATORY, LOOKING TOWARD AFTER-PORT SIDE.

Drawn by C. B. Hudson.

UNDER DECK ARRANGEMENT.

(See Plates III to XI.)

The under deck space is divided generally into the forecastle, hold, laboratory, cabin, and sail-room.

Forecastle and galley.—The forecastle (Plate V), which is also used as a galley for cooking, and as a sleeping apartment of the seamen, the cook and cabin-boy, and the quarters where they eat, is under deck forward, and is about 22 feet long; it conforms in width to the shape of the vessel. It is finished with ash and black walnut, and has three lengths of berths on each side. There is a dish closet on the starboard side next to the after berths, and a locker or closet for cooking utensils abaft the dish closet. The galley stove sits on a platform, about 3 inches high, on the starboard side next the after bulkhead. On the port side aft is a water-closet and lavatory. On each side of the forecastle is a locker seat, 18 inches high and 9 inches wide, fitted underneath at the after end with two drawers for clothing. The forward end of the lockers are provided with adjustable scuttles so that the interior may be utilized for the storage of such material as it is necessary to put into them. The space underneath the fore-peak berths is finished with closets for the storage of lanterns, etc. The table, which is 5 feet 9 inches long, is made with leaves so that when not in use it will fold around the foremast, leaving the floor space clear of obstruction. There is a scuttle in the floor forward and one abaft of the foremast, to give entrance to the space underneath the floor. The floor is double, being made of 1-inch ash boards over 1-inch hard pine boards; these are fastened with galvanized iron screws $2\frac{1}{4}$ inches long. The sleepers, upon which the floor is laid, are 4-inch by 3-inch scantling and are supported by stanchions, cleats, etc., as needed.

Hold.—The floors of the hold and laboratory are made of 2-inch hard pine, laid on sleepers which are 4-inch by 5-inch, supported by stanchions, cleats, etc., to prevent them from springing or sagging. The hold is divided, as shown in the plan. On the port side, next the forecastle bulk-head, is a refrigerator, in which meat or other stores can be kept cool in warm weather. This is provided with a door at top and bottom, and with the necessary gratings, hooks, etc. The bottom and sides of the refrigerator are covered with galvanized iron, soldered together and well fastened, and from the after corner a lead drain-pipe, fitted with a trap for draining water, leads into a reservoir below, which can be pumped out through another tube into which an adjustable brass hand-pump is screwed. Abaft the refrigerator, on the same side, is a cupboard or grub-locker, for keeping food, dishes, etc. Next the grub-locker, on the same side, is a store-room or cook's pantry, in which the stores in daily use are kept (with the exception of meats), and which is so arranged that the cook may do much of his work therein. Between

the store-room and the laboratory bulkhead on the port side are two pens, which are ordinarily used for the storage of fishing apparatus, and can also be used for the storage of ice, or for icing fish, bait, etc. There are two similar pens opposite on the starboard side, and in each case these pens are provided with piping, which carries the drainage from them into a reservoir beneath, which can be pumped out by a hand-pump in the same manner as that connected with the refrigerator. This prevents the drainage from getting into the bilge and making the bilge-water offensive. Forward of the two pens, on the starboard side, is a coal and wood pen, in which a supply of fuel is carried. The pens are provided with sliding doors, which run in grooves at top and bottom. Inside of these doors are vertical grooves in the stanchions on each side of the entrance, in which boards can be slid to close the aperture gradually when using a pen for icing fish, etc. Of course, after the fish are iced, the main door is closed also.

Abaft the forecastle bulkhead are the chain-lockers, previously referred to, in which the chain cables are stowed (see Plate VI). These are separated by a bulkhead in the middle; they are 20½ inches fore and aft, 5 feet 4 inches long athwartship (outside measurement), and extend from floor to deck, a height of about 6 feet. They are built of 1¾-inch spruce plank, and fitted with sliding planks on after side which can be removed, so that the chains inside may be reached whenever it is necessary.

Attached to the after side of the chain-box, 2 feet 6 inches above the floor, is a plain pine table for cook's use, 4 feet 7 inches long and 2 feet 1 inch wide. It is hung on hinges and provided with swinging legs, so that it can be let down when not in use. The after corners are rounded.

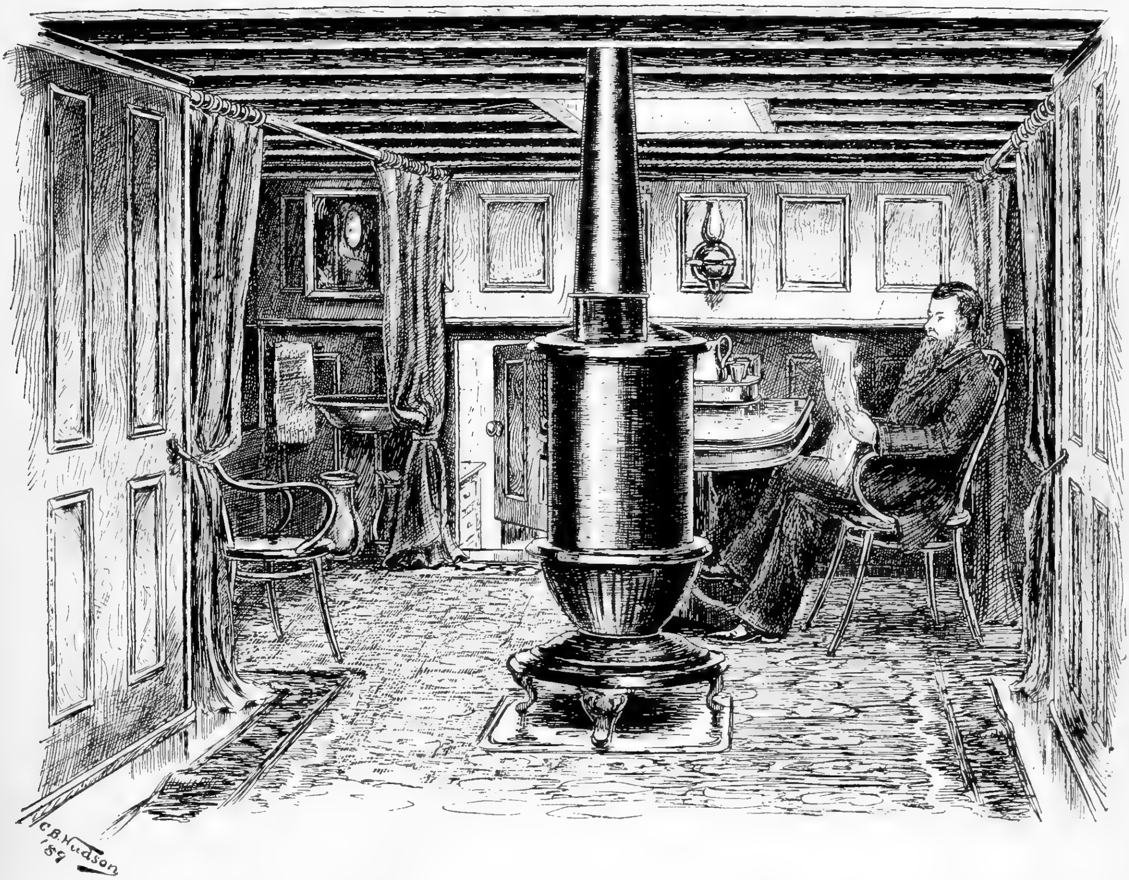
On the starboard side, forward of the coal pen, are a series of shelves, some with holes and all provided with racks or rails, to hold firkins, galley coppers, etc.

The well occupies the middle of the hold, and on each side of this is a passage-way connecting the forecastle with the laboratory and cabin; it is 17 inches wide at the floor and 34 inches wide at top (see Plate VII).

There are adjustable ash steps leading from the fore hold to the deck, through the main-hatch, on the forward side of the well.

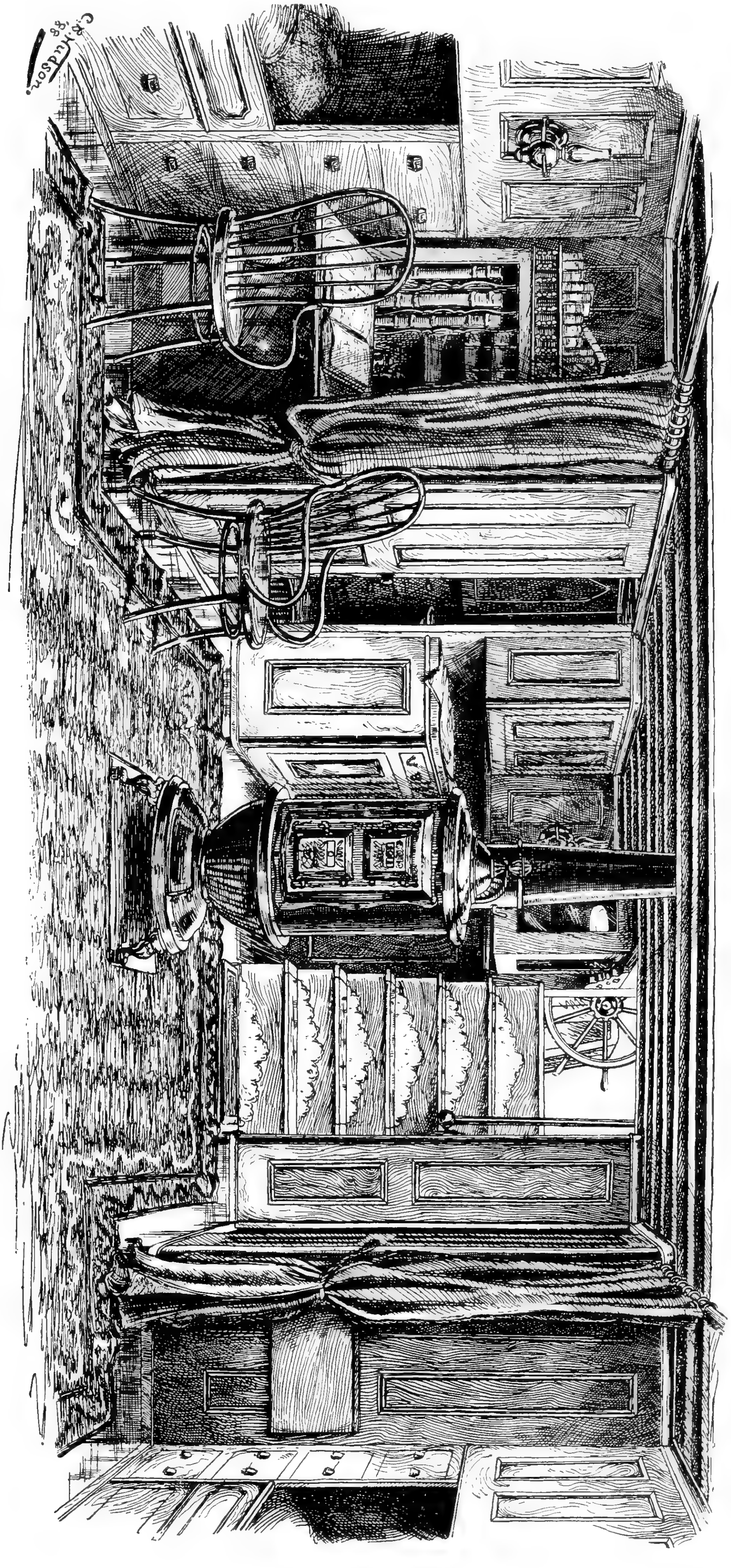
A harness cask is stowed on each side abaft the well, and provision is made by staples, etc., for hanging harpoons, boat-masts, sprits, etc., over head alongside the well. The pumps are cased in with white pine.

Laboratory.—The laboratory (see Plates VIII and IX) is abaft the hold, between that and the cabin, separated from each by a bulkhead, access being had to the hold by a door on each side, and to the cabin by a door on the port side. The laboratory extends the full width of the vessel, and is 9 feet 6¾ inches fore and aft from bulkhead to bulkhead. A flight of wooden steps leads to the deck through the after booby-hatch. On each side is a shelf, 2 feet 8½ inches high, with an average width of 3 feet 10 inches covered with sheet lead to make it water-tight, and fitted with a low adjustable black walnut railing in front. Underneath these



CABIN, LOOKING FORWARD.

Drawn by C. B. Hudson.



CABIN, LOOKING AFT.
Drawn by C. B. Hudson.

shelves are built a series of sliding drawers—eight on starboard side and seven on port side—in which are kept various kinds of fishing gear, apparatus for loading guns, flags, charts, etc. On top of the starboard shelf, at the after end, is a set of drawers—four in all—2 feet 2 inches deep and 3 feet 10 inches long, in which are kept spare bedding, and on the forward end a closet with two glazed doors, and series of drawers, for containing medicines. The closet extends to the deck; it is 10 inches deep and 2 feet 10 inches wide. The drawers are each 7½ by 11 inches front. On the after end of the port shelf is a closet 15½ inches deep and width of shelf, to hold the vessel's library, and just abaft that, near the entrance to the cabin, is a water-closet. Across the after end of the laboratory is arranged a series of sliding drawers—nineteen in all—each 21 inches by 20½ inches by 6 inches, outside measurement, to hold bottles, jars, etc., in which the collections are placed. These drawers are held in a case 8 feet 1 inch long, 3 feet 11 inches high, and 2 feet 2 inches deep. It is provided with four wire-screen doors that lock at side, top, and bottom, and it is 2 feet 1½ inches above the floor. The lower drawers are thus high enough to receive beneath them large alcoholic tanks. The finish of the laboratory is generally in ash and black walnut, but it is sheathed over the ceiling with hard pine, and white pine is also used to some extent. The hard wood is finished bright and varnished; the rest, including deck and beams, is painted white.

The fog alarm, when not in use, is stowed back of the laboratory steps, next the forward bulkhead. The rifles, axes, etc., are supported in cleats on forward bulkhead and between beams and carlines overhead. The laboratory is lighted at night by a large brass double-burner lamp, which hangs over the starboard shelf.

Cabin.—The cabin (see Plates X and IX) is finished in cherry and bird's-eye maple, with the exception of the interior of the state-rooms, which is finished in ash, black walnut, and white pine, the pine being painted in parti-colors. The floor is similar to that in the forecastle. The ceiling is white pine, painted white. There are two state-rooms, one on each side in the after end of the cabin, and heavy draperies or curtains, which slide upon poles, make it possible to shut off the forward berths on each side from the rest of the cabin.

In the starboard state-room is a writing-desk made of bird's-eye maple and cherry, and a similar desk is placed just abaft the after end of the berth next forward of it. In the port state-room, and next to the berth forward of it, are "drop" tables for writing. There are drawers underneath each of the berths and abaft them for clothing.

There are but four berths in the cabin, but these are fitted with a device originated by the writer, so that they can be extended when necessary, to make ample room for two persons in each berth. When not in use they can be easily closed. The forward berths are also provided with an adjustable arrangement, for use in rough weather, to prevent the occupants from falling out.

There is an extension table of black walnut, 3 feet wide and 8½ feet

long, to its limit. There is a box binnacle on the starboard side of the cabin, 26 inches high and 14 by 15 inches square (outside); the binnacle lamp is hung to starboard of the box so as to throw the light upon the compass. On the starboard side, aft, is a sideboard and china-closet, and between the sideboard and companion-stairs is a door giving entrance to the sail-room. Just forward of the foot of the cabin stairs, nearly amidships, is a scuttle leading into a small store-room beneath the floor. In the forward part of the cabin floor, each side of the midship line beneath the table, is a scuttle leading to corresponding scuttles in the top of the water tank.

On the starboard side, in front of the forward berth, are two scuttles which form a cover to the bath-tub that is located beneath the floor, and which is provided with proper piping for filling it from the deck.

The cabin is heated by a stove.

Sail-room.—The sail-room occupies the extreme after end of the vessel, next to the cabin. It has a locker built of white pine on each side, and a small floor placed at the proper height; otherwise it is unfinished. In this are stowed the spare sails, cordage, blocks, awnings, paints, etc.

Water-tanks.—Forward of the well, on each side, is an iron water-tank, extending several feet underneath the after end of the forecastle floor and having a capacity of about 270 gallons; the two tanks hold some 540 to 570 gallons of water. Beneath the cabin floor is a wooden tank (built to conform with the shape of the vessel, and divided into two main sections by a tight bulkhead running fore and aft) which holds about 1,500 gallons of water. This is connected by piping with the tanks forward, so that water can be draughted from the after tank to the iron tanks. It also has adjustable cross bulkheads, that are perforated with holes, to prevent the water from swashing.

8. WINDLASS AND ENGINES.

(See Plates XII and XIII.)

The windlass originally put upon the *Grampus* was fitted to be operated by steam or hand, being of the pump-brake pattern, built by the American Ship Windlass Company, of Providence, Rhode Island. It had two loosely mounted wild cats fitted for 1-inch or 1⅛-inch chains, and they were adapted to lock to rigidly secured driving-heads keyed on the shaft and each controlled by a friction-band and lever. The windlass was provided with adjustable gypsy ends to be used for warping and for heaving in the beam-trawl. It was also fitted with adjustable whelps for the port wild-cat, so they could be put on whenever it was intended to use the steel wire hawser. The windlass-bitts were bolted to an iron bed-plate.

It was driven by a pair of right-angle engines of 35 horse-power, which were bolted underneath the deck upon which the windlass stood. The steam-power was communicated through a worm-shaft operating upon a worm-wheel on the windlass.

Fig 1

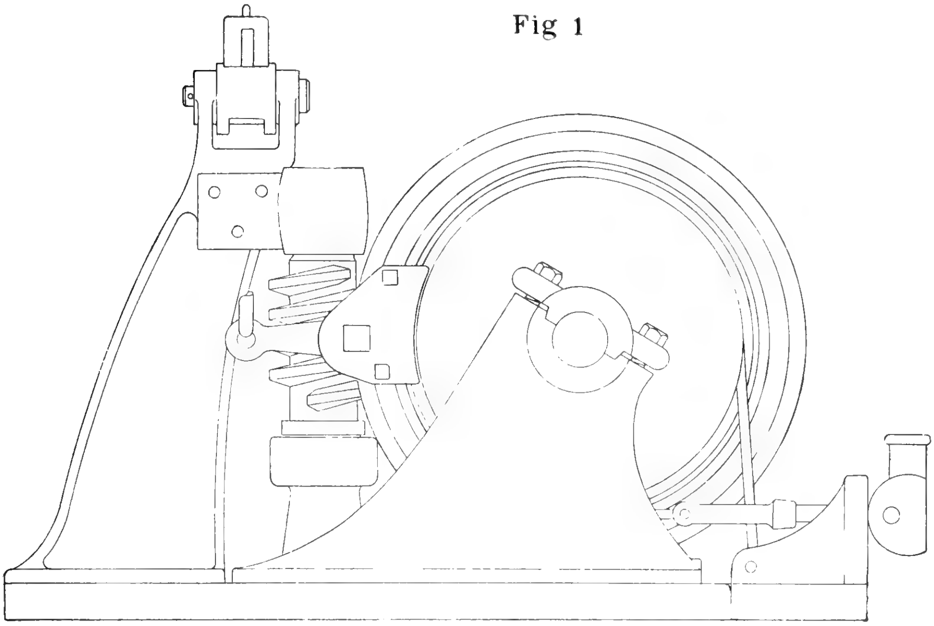


Fig. 2.

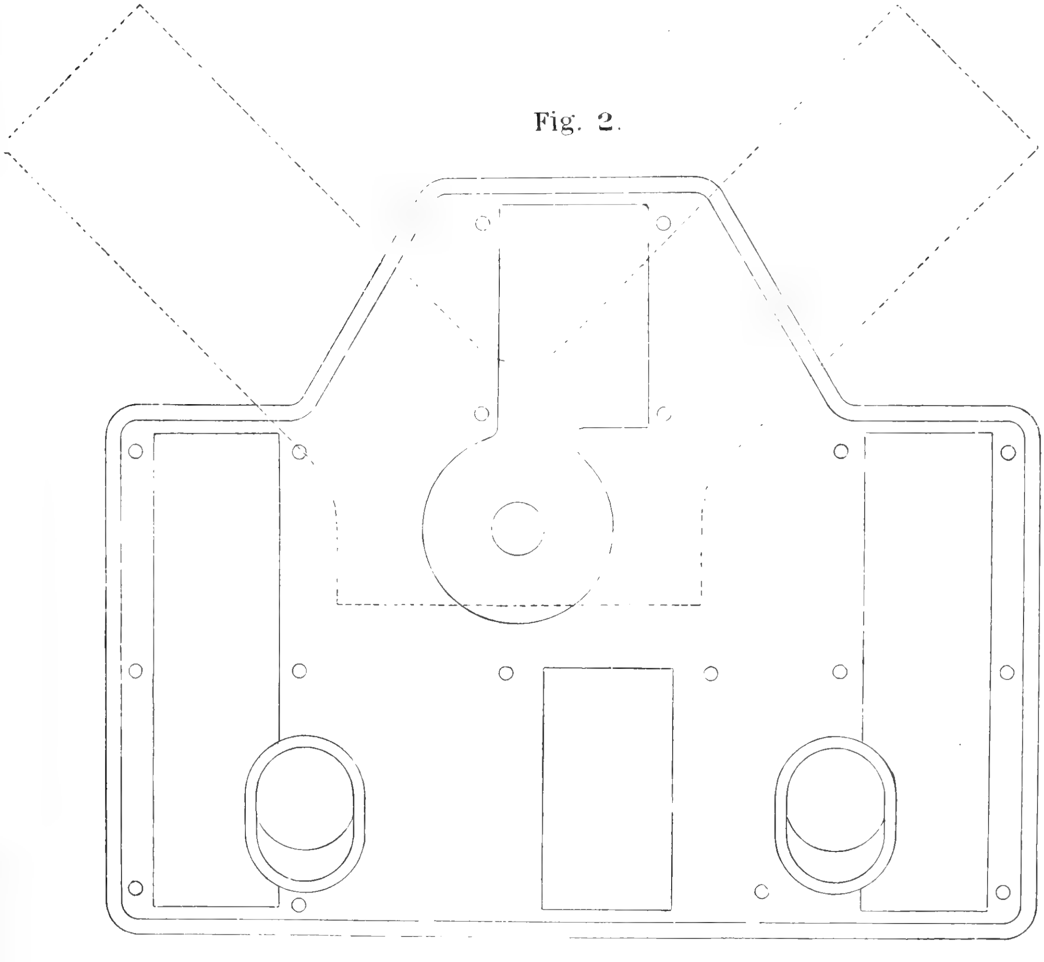


FIG. 1. Cross-section of steam windlass.
FIG. 2. Bed-plate of steam windlass; the dotted lines represent the outlines of the engines.

Fig. 1.

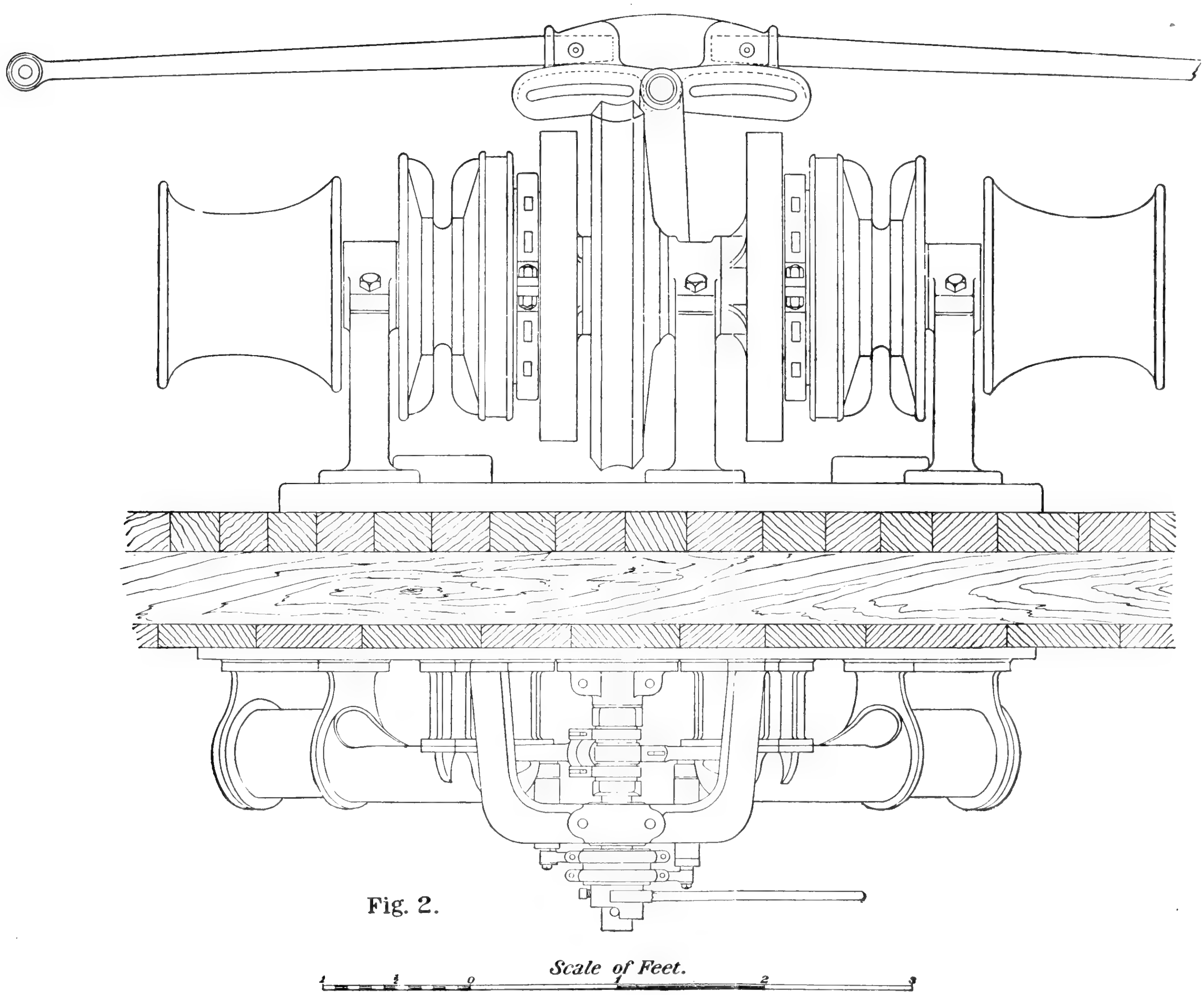


Fig. 2.

FIG. 1. Plan of steam windlass, looking forward.

FIG. 2. Plan of engines for windlass.

The hand-power or pump brake arrangement for working the windlass when steam was not used was so arranged that it could be geared to obtain different degrees of purchase power.

The weight of the windlass and engines (exclusive of the 24-inch gypsy ends) was 5,800 pounds. The gypsy ends had a combined weight of 1,000 pounds, making a total weight, including these, of 6,800 pounds.

As has been stated elsewhere, the steam windlass was removed after the vessel made one trip and replaced by a common wooden pump-brake windlass, of the type used on fishing-vessels of the same size. This windlass is 19 inches diameter in the middle, 14 inches on starboard barrel, and 22 inches on port barrel, over whelp. It is arranged for chain on the starboard side, and is fitted with a hard-wood jacket or smooth whelp on the port side for the steel hawser, which is generally used, though it is also adapted to a chain-cable.*

9. STEAM BOILER, FORCE PUMP, CONDENSER, ETC.†

A 20 horse-power Brayton patent coil boiler was used for operating the steam windlass. This was 6 feet high and 5 feet in diameter; provided with an adjustable pipe or smoke-stack, 1 foot in diameter and 6 feet long, made in two lengths so that it could be shortened or removed altogether, as occasion required. There was a brass deck-plate for this pipe to pass through, and this was provided with a water-tight brass cover that was put on when the pipe was taken off.

The boiler was located between the well and the forecastle; it was connected with a Knowles combined vacuum and force-pump (located to starboard against the ceiling) and with a keel-condenser. The latter was made of heavy 2½-inch seamless brass tubing, and was 28 feet long outside of vessel—14 feet on each side of keel, through which it passed. The 2½-inch pipe began at boiler-room deck (floor of fore-hold) inside of the vessel, and continued of that size until it passed through the keel and returned to enter the vessel on the port side, where its size was reduced to 1½ inches diameter for suction-pipe of vacuum pump, and continued of that size above boiler-room floor.

There was a brass sea-valve of 1½ inches diameter, fitted with strainer over its end.

The requisite piping for connecting the boiler with the steam-engine passed through the forecastle bulkhead to starboard of the stove, thence under locker seat to engine.

10. CHAIN STOPPER.

One of the Emery and Cheney patent elastic chain stoppers is located close to the hawse-pipe on the starboard side.

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* The windlass originally put on the *Grampus* was transferred to the U. S. Fish Commission steamer *Fish Hawk*.

† These were all removed when the steam windlass and engines were taken off the vessel.

11. RIGGING.

The standing rigging, with the exception of foot-ropes, life-lines, and a few pennants, is galvanized iron wire; the running rigging is manilla. The following are the sizes of rope:

	Inches.
Wire rigging:	
Jib-stay and bobstay	4½
Forestay and fore and main shrouds	3¼
Spring-stay (or triatic-stay) and preventer-stay	3
Bowsprit shrouds	2¾
Flying-jib and jumper-stays	2½
Back-ropes	2¼
Inner jib-boom guys, outer jumper-stay, fore and main-topmast back-stays, foreboom, and fore-staysail topping-lift pennants	2
Balloon-jib stay and outer jib-boom guys	1¾
Main-topmast stay, "counter-stay" (from head of fore-topmast to main-mast-head) fore and main-topmast shrouds	1½
Upper topmast stays and belly lashing for jib-boom	1
Hemp ropes:	
Jib foot-ropes and life-lines	2¾
Main-boom foot-ropes and jib-boom foot-ropes	2½
Ratlines, size universally used	
Manilla rope:	
Main-boom topping-lift pennant (four strands)	4½
Main-boom tackle pennant (four strands)	4
Fore-boom tackle pennant (four strands)	3½
Main-boom topping-lift runner	3
Boat-gripes	3
Tarred manilla lanyards (four strands) for fore and main rigging	3
Tarred manilla lanyards (four strands) for head rigging and fore-topmast back-stays	2
Main sheet, fore- and main-peak halyards	3
Fore- and main-throat halyards, fore sheet and cat stoppers	2¾
Jib halyards, fore-staysail halyards, fore-staysail sheet, jib sheet, after main-staysail halyards, main-staysail sheet, main-boom tackle fall, balloon jib sheet, davit tackle falls, and reef earings	2½
Forward main-staysail halyards, flying-jib halyards, flying-jib sheet, fore-boom tackle fall, gaff-topsail halyards, gaff-topsail sheets, crutch tackles, main-boom topping-lift fall, fore-staysail topping-lift fall and main top-mast back-stay fall	2¼
Fore-staysail and jib down-hauls, fore-boom topping-lift fall, fore and main-peak down-hauls, gaff-topsail tacks, reef tackle, main-peak and fore-peak whips, and foot lacings for sails	2
Balloon-jib halyards, flying-jib down-haul, fore and main gaff-topsail clew-lines, and jib stops	1¾
Head lacings for sails and sail gaskets	1½

The pennant halyards are special size, cotton line, made for that purpose.

12. BLOCKS, TRUCKS, LEADERS, PINS, ETC.

The blocks are, generally, made of ash with lignum-vitae sheaves, provided with iron or patent bushings, as specified in the list, and steel pins. The straps are generally galvanized iron, and are inside of the shell of the block. A few of the blocks are made of lignum-vitae, as indicated, and in some cases iron sheaves are used.

No.	List of blocks, etc.	Size.	Bushing.
	MAINSAIL.		
		Inches.	
1	Three-fold main peak	12	Patent.
2	Single-fold main peak	12	Do.
1	Three-fold main throat	12	Do.
1	Two-fold main throat	12	Do.
1	Three-fold main-sheet	12	Do.
1	Two-fold main-sheet (lignum-vitæ)	12	Do.
1	Single-fold runner main-boom topping-lift	7	Do.
1	Single-fold upper main-boom topping-lift	8	Iron.
2	Single-fold main peak-whips	7	Do.
1	Single-fold main peak down-haul	5	Do.
2	Two-fold main crutch tackles	7	Do.
2	Single-fold main crutch tackles	7	Do.
1	Two-fold main-boom tackle	9	Patent.
1	Single fold main-boom tackle	9	Do.
1	Two-fold main reef tackle	6	Do.
1	Single-fold main reef tackle	6	Do.
	FORESAIL.		
1	Three-fold fore peak	12	Patent.
2	Single-fold fore peak	12	Do.
2	Two-fold fore throat	12	Do.
1	Two-fold fore-sheet	11	Do.
1	Single-fold fore-sheet (lignum-vitæ)	11	Do.
2	Single-fold fore boom topping-lift	8	Do.
2	Single-fold fore peak whips	7	Iron.
1	Two-fold fore-boom tackle	7	Do.
1	Single-fold fore-boom tackle	7	Do.
	FORE STAYSAIL.		
1	Single-fold fore staysail halyards	9	Patent.
1	Two-fold fore staysail halyards	9	Do.
1	Single-fold fore staysail down-haul	7	Do.
6	Single-fold lignum-vitæ (round) staysail sheet	8	Iron.
2	Single-fold topping-lift blocks	8	Patent.
	JIB.		
2	Single-fold jib halyards	9	Patent.
1	Single-fold jib down-haul	6	Do.
2	Single-fold lignum-vitæ (round) sheet	7	
	FLYING JIB.		
2	Single-fold flying-jib halyards	7	Patent.
1	Single-fold flying-jib down-haul	5	Do.
2	Single-fold flying-jib sheet (round)	6	
	JIB TOPSAIL.		
2	Single-fold jib-topsail halyards	6	Patent.
1	Single-fold jib-topsail down-haul	5	
	FORE AND MAIN GAFF-TOPSAIL.		
2	Single-fold gaff-topsail sheets	7	
4	Single-fold gaff-topsail halyards	6	Iron.
6	Single-fold gaff-topsail clew-lines	4	Do.
2	Cleats on gaffs with sheaves	......	
	MAIN STAYSAIL.		
2	Single-fold staysail halyards	7	
1	Staysail tack club	......	
	MISCELLANEOUS.		
30	Locust belaying-pins	......	
6	Iron belaying-pins	......	
30	Purrel or peril trucks for gaffs	......	
12	Dead eyes for shrouds	6	
4	Heart eyes for jib stays and guys	$4\frac{1}{2}$	
2	Gilded trucks (balls)	......	
11	Riding-sail hoops with hooks	......	
8	Dory tackle blocks, rope straps (single)	6	Patent.
2	Two-fold davit tackle blocks	8	Do.
2	Single-fold main-topmast back-stays	7	Iron.
2	Two-fold main-topmast back-stays	7	Do.
4	Two-holed fair leaders for gaff-topsail gear	......	

Lightning rods.—Lightning rods extend from the top mast heads to the water on the starboard side, passing through fair-leaders on the topmast back-stays. The rods are flexible copper wire rope, with copper tips extending above the trucks about 6 inches. The lower ends are coiled up and tied to the back-stays, 7 or 8 feet above deck, except in stormy weather, when they are unloosed and thrown into the water.

13. SAILS, SAIL-COVERS, AND AWNINGS.

(See Plate XIV.)

The original suit of sails, sail-covers, and awnings, were made of medium-hard Woodbury duck of the ordinary width, and of the following thickness: Foresail, fore staysail, and riding-sail, No. 0; mainsail and jib, No. 1; flying jib and sail covers, No. 6; fore and main gaff topsails, No. 8; main topmast staysail, No. 10; balloon jib, 8-ounce duck.

The sail-covers and awnings are made of cotton duck.

The awnings are made in two sections to extend from foremast to taffrail; they meet at the mainmast.

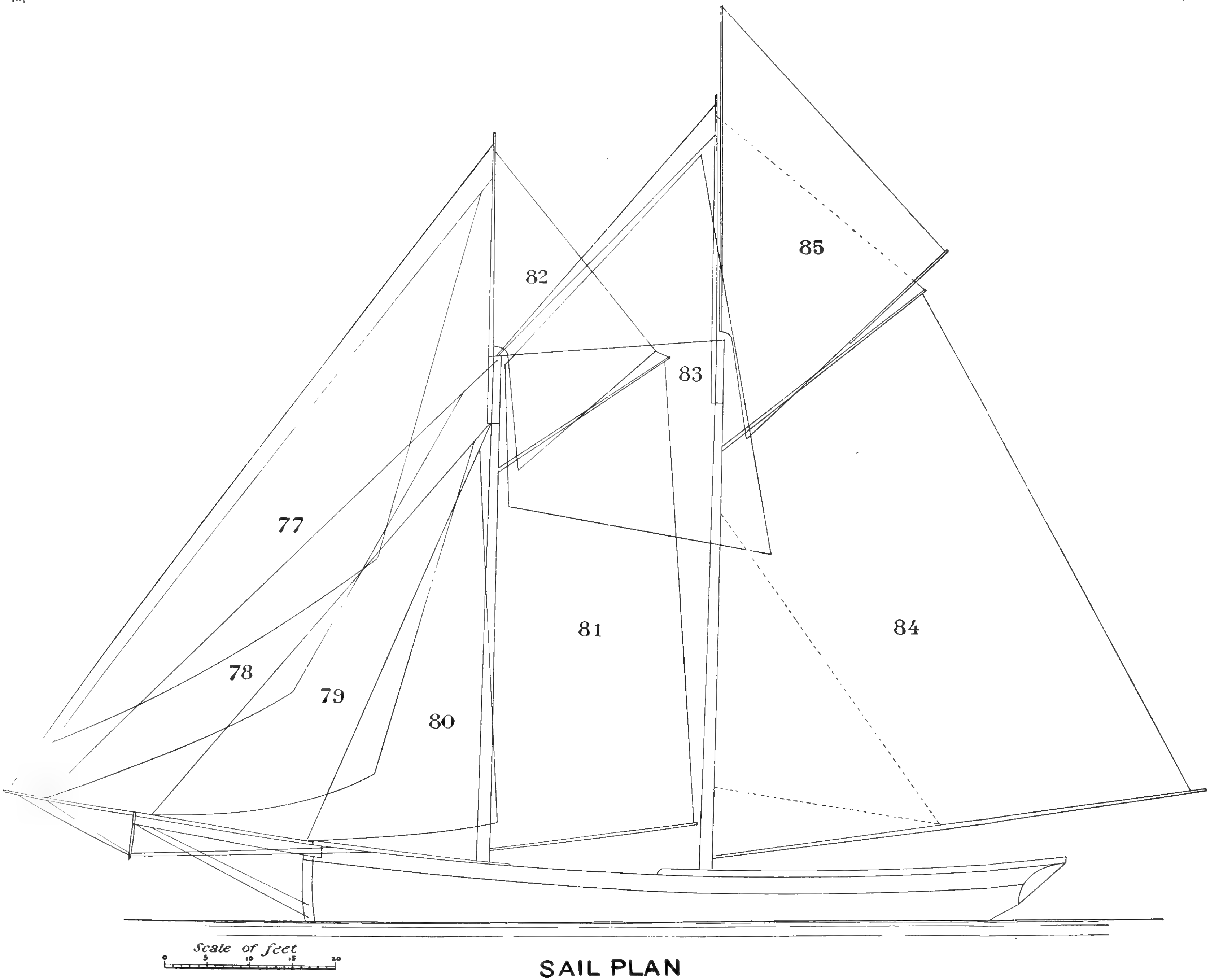
A second suit of sails was made of hard Woodbury duck, 14 inches wide, and of the same thicknesses as those given above, with the exception of the foresail and fore staysail, which were made of No. 1 canvas. No riding-sail was made in this suit. All the sails, sail-covers, and awnings, as well as a portion of the running rigging, have been treated with Nelson's preservative for preventing rot and mildew.

14. ANCHORS AND CABLES.

The anchors are of the special pattern used on fishing vessels, having large palms and long shanks, the latter designed to receive wooden stocks. The kedge, however, is provided with an iron stock. Two of the anchors weigh 700 pounds; a third anchor 500 pounds, approximately, and the kedge weighs 200 pounds. The chain cable is 1-inch, barred; in two strings of 60 fathoms each. The hawser is the Bullivant elastic steel-wire cable, 1 inch in diameter. There are 400 fathoms of this, of which only 175 fathoms have yet been used.

15. COLLINS' IMPROVED MARINE DRAG.

This drag (or drogue) is made of galvanized iron and canvas. The frame consists of a stout hoop of round galvanized iron, jointed so that it can be folded and stowed away in small compass when not in use. It is fitted with lugs, into which are fastened the cross bars that keep it distended when rigged, and to four other lugs are attached chains, that together form a bridle from the four quarters of the hoop and join, at a common center, to a large swivel which is fitted with a big thimble into which a hawser can be bent.



SAIL PLAN

Designed by J. W. Collins.

To the hoop is attached, by sister hooks, a deep canvas bag, shaped like a skull-cap, which will fill with water when thrown overboard and hold the vessel steady, nearly head to the sea and wind, and with only a moderate leeway. The drag, when in use, is secured to the end of a hawser, and it can be suspended at any required depth by means of a buoy. A line is attached to the bottom of the bag so that it can be tripped and easily hauled in when its use is no longer necessary. The advantages of this drag are that it is always ready for use, being easily adjusted in a few moments when needed; that it can be unrigged and stowed away when not in use.

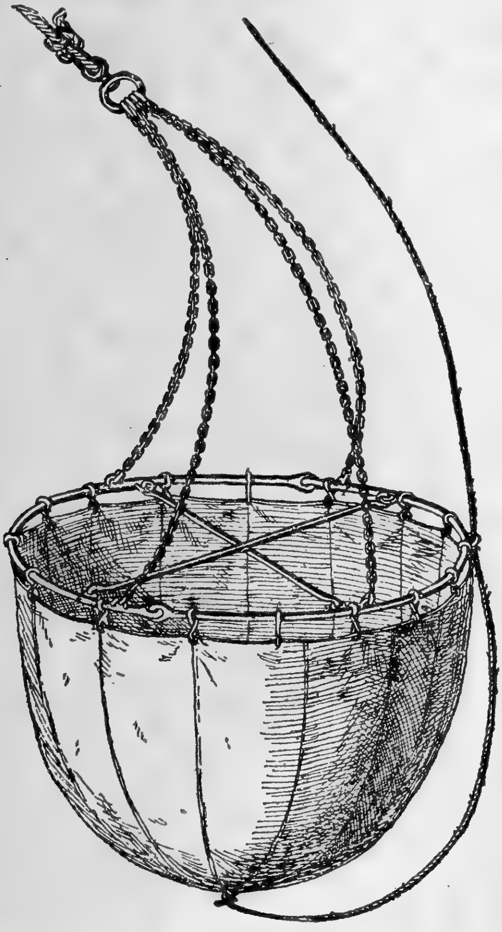


FIG. 2.—Collins' improved marine drag.

Dimensions: Circumference of hoop, 18 feet; length of cross-bars, 5 feet $10\frac{1}{2}$ inches; size of iron, $1\frac{1}{4}$ inches; length of bridle-chains (each), 5 feet; circumference of bag, 19 feet; depth of bag, 4 feet; canvas (No. 1), white cotton duck.

This drag was designed to insure the greater safety of vessels in heavy gales, and also to prevent them from drifting so rapidly to leeward as they usually do when it is not employed. It is secured to a hawser or chain and paid out from the bow of the schooner, the distance varying from 25 to 75 fathoms. A bag containing oakum saturated with oil can be used, in connection with the drag, to smoothen the sea, and thus, to a still greater extent, insure the safety of the vessel.

16. FOG-HORNS.

Collins' patent fog-alarm.—(See fig. 3.) This consists of an upright cylindrical bellows of stout grain-leather, supported by and working upon three brass rods which are fastened at the lower ends to a galvanized iron pedestal, and the upper ends of which are secured, by means of screw-caps, to an iron top, to which also is attached the upper part of the bellows. This cap piece is surmounted by a cone-shaped top, having a hole in its apex into which is screwed a large reed horn fitted with a revolving top or cowl by means of which the sound can be thrown in any desired direction. There are three of these horns, so that in case one is injured it can be instantly replaced by another.

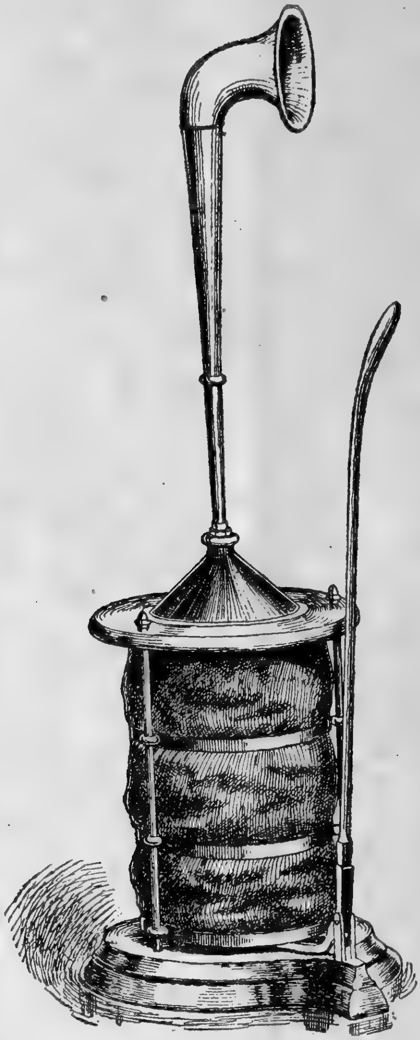


FIG. 3.—Collins' patent fog-horn.

The bellows is collapsed or distended by means of an iron lever working on a hinge attached to the base. By moving this lever the air in the bellows is driven through the horn at the top with great force. A very heavy sound is obtained, while the horn can be blown to its fullest capacity with very slight exertion on the part of the operator.

This implement was originally designed for use on fishing vessels, especially such as are employed in the trawl-line fishery; it is adapted

for use on all classes of vessels. Dimensions, diameter of base, 2 feet; thickness, 4 inches;* diameter of top, 19 inches; diameter of bellows, 15 inches; height, 20 inches; height of cone, 6½ inches; diameter of cone (at base), 9 inches; thickness of brass rods, five-eighths of an inch; length of lever, 4 feet.

Tin fog-horn.—There is a common, reed, tin fog-horn to be blown by the mouth. This is about 3 feet 6 inches long.

C.—BOATS AND LIVE CARS.

There are five boats, namely: one purse-seine boat, one stern-boat or dinghy, and three dories. Besides these, there are three boat shaped live cars.

17. SEINE-BOAT.

The seine-boat is like the ordinary type used in the purse-seine mackerel fishery. It is sharp forward and aft, and is carvel built. The frames, gunwales, etc., are of white oak, and the planking is white swamp cedar, fastened with the best quality of galvanized iron. The boat is fitted with special galvanized malleable iron appliances, as specified in the detailed description. She is provided with a schooner rig of spars and sails, and carries, when sailing, a jib tacked down to the stem-head, a loose-footed gaff foresail, and a sprit and boom mainsail, the latter being much smaller than the foresail. The foresail is bent to hoops, and has two reefs in it. The mainsail and jib are not provided with reefs. The sails are made of cotton drilling, and, like the sails of the vessel, have been treated with Nelson's anti-mildew preparation. They have a total area of 50 square yards. All the spars are of spruce. There are special casings under the thwarts into which the spars are stepped so that the latter can be put in or taken out without interference with fish or nets that may be in the boat. The latter is fitted with an oak rudder that can be used when sailing, and which is hung by gudgeons to straps that are attached to the stern-post, and so formed as not to entangle the seine when the latter is being used, at which time the rudder is unhung. The boat is also provided with a white oak, brass bound, water-breaker, holding 5 gallons.

The following is a detailed description of the boat: Length, over all, 33 feet; breadth of beam to outside of planking, 7 feet 2 inches; depth from top of keel to top of gunwale, amidships, 2 feet 6 inches.

Keel.—The keel is made of oak in two parts, commonly called "partners" or sister keels. The lower or outer portion is 2¼ by 2¾ inches. The inner "partner" is 4¾ by 1 inch. This is nailed to the lower part with galvanized iron sheathing nails.

Stem and stern-post.—Of "pasture" white oak; bent to the proper form, the upper end of each nearly perpendicular, and from thence curv-

*The thickness of iron averages about three-sixteenths of an inch; the thickness given above relates to the vertical dimension of base.

ing to meet or intersect the keel, to which both stem and stern-post are joined by a splice, with a clamp over the splice, and bolted together with galvanized iron bolts $\frac{1}{4}$-inch diameter.

Aprons.—It has a white oak apron $2\frac{1}{4}$ by 3 inches, bent to fit inside of the stem and properly fastened; also a similar apron, $1\frac{1}{2}$ by 3 inches, bent and fitted inside of stern-post.

Ledges.—There are ledges between each timber, from the fifth timber from the bow to the fifth timber from the stern; these are oak, $\frac{7}{8}$-inch thick and averaging 7 inches high, and are fitted to the plank and on top of keel; the top of each ledge to receive the platform.

Frames.—The timbers are made of white oak butts, steamed and bent to the proper curve, $1\frac{1}{8}$ by $1\frac{3}{8}$ inches, and are notched over lap of top streak. They are spaced 12 inches from center to center; are nailed on each edge of every streak, the nails going through plank, battens, and timbers; and the foot of the timbers are fastened through back to rabbet or upper portion of the keel into the lower or outer keel.

Plank.—The plank are of white swamp-cedar $\frac{9}{16}$ inch thick, and have had at least two years atmospheric seasoning.

Battens are of elm; they lap $\frac{7}{8}$ inch on each edge of plank—either side of seams—and are $\frac{9}{16}$ inch thick.

Ribbands.—The lower chafe ribband is three-fourths round, $1\frac{3}{4}$ inches wide by $\frac{7}{8}$ inch thick, and made to fit under the upper streak of plank. The top ribband is 3 inches wide by 1 inch thick amidships, tapering to 2 inches in width at either end; it is nailed at the ends, but amidships it is bolted through the gunwale and forelocked on the inside, and the lower edge is riveted through plank and timber heads.

Risers are of spruce, 4 inches wide by $\frac{7}{8}$ inch thick.

Ceiling is $\frac{9}{16}$-inch thick; in narrow strips, and closely fitted from gunwale to riser (or rising) and from riser to platform.

Platforms.—The platforms are of white pine $\frac{7}{8}$ inch thick, laid on top of the ledges. There is a forward platform extending from forward thwart to stem, and dropped 5 inches below the thwart. The after platform commences at the bulk-head, at the fore part of the stern deck, and extends to and covers the after thwart; there is a bulk-head from this after platform downward to the lower or main platform.

Thwarts are of spruce, $1\frac{3}{8}$ by 8 inches, except the midship thwart in which the pursing davit is fixed, which is of oak.

Knees are of juniper $1\frac{1}{8}$ inches thick, with the horns finished $1\frac{3}{4}$ inches; these are bolted through ribband, gunwale, and the head or horn of the knee; also one bolt through each knee, the chafing ribband, plank, timber, and ceiling. All these bolts are forelocked over rings.

Breast-hook is of galvanized malleable iron, with one bolt through its throat, thence through apron and stem, and riveted on the outside. It has three bolts through each arm.

Stern-hook is of galvanized malleable iron, and fastened in the same manner as the other.

Stem-cap is of malleable galvanized iron, of suitable size and shape to cover stem-head, rounded off to prevent its marking the vessel, and has flanges on either side to take the wear of towing link.

Stern-deck.—There is a stern-deck of $\frac{7}{8}$-inch white pine (except the after-piece, which is of oak, to support the after ring-bolt) fitted to top of gunwales, and extending from stern-post to the bulkhead of the upper after platform.

Thwart stanchions.—There is an eight-square ash stanchion, $1\frac{1}{2}$ inches diameter, under each of the four thwarts known as the second, third, fourth, and fifth thwarts.

Pump.—A wooden pump of the ordinary pattern used on seine-boats; this is fitted with a spout to carry the water over the boat's side, and has a galvanized iron spear and box, the latter properly leathered and fitted for use.

Thwart knees.—The first, second, and sixth thwarts each has a single knee at either end, and the third, fourth, and fifth thwarts have two knees at either end of each thwart.

Gunwale supporters.—There is a gunwale supporter, of galvanized malleable iron, on each side of the boat; this is bolted through the gunwale and upper ribband, and also has one bolt through the lower or chafing ribband.

Butt clamps.—There is a clamp on each butt of the planking. This clamp laps far enough over the ends of each plank, so that two rows of nails may be driven into either end of the clamp.

Calking.—All butts, wood ends, and garboard seams are calked with cotton.

Plank fastening.—The planking is nailed through the edge of each streak to the battens, and has three nails in the space between two timbers, these nails being 4 inches apart.

Hooks and garboard jumpers.—There are two natural-growth juniper hooks, bolted through keel and nailed through plank streaks. There are also six garboard jumpers in each end of the boat, extending from the keel upward over three streaks of plank on each side, these jumpers being fastened to keel and plank.

Hoisting ringbolts.—There is a hoisting ringbolt of galvanized wrought-iron forward and aft. The bolt at the stern goes through the after-deck; the lower end of the bolt is flattened and pierced with two holes to receive bolts that secure it to the stern-post.

Rowlock sockets.—There are eight sockets for the rowlocks, each secured with four screws. These sockets are of galvanized iron.

Fastening of ledges.—The ledges are nailed diagonally through the bottom into the keel, and through the planking and battens into the ledges, the upper ends having rivets turned down so as to form a clench.

Painting, etc.—The boat is painted with three full coats of paint inside and out. The bottom, outside, below water line, is painted with

pure French verdigris. The inside of the planking, underneath the ceiling, is payed with bright varnish, with enough dry paint mixed with it to make a heavy body. The color of the boat is as follows: The bottom, below water-line, green; the bends, white, with vermilion stripe; the top streak, gunwale, and inside top work, as far down as the lower edge of risings, straw color; the platform, green, and the ceiling amber color.

Oars.—The oars are straight-grained white ash, of the following dimensions: One steering oar, length, 16 feet; two rowing oars, length, 14 feet; four rowing oars, length, 13 feet; two rowing oars, length, 12 feet.

Fittings.—The boat is provided with the following articles of equipment. All these implements are of the best galvanized malleable or wrought iron:

10 row-locks, of seine-boat pattern.
2 patent steering row-locks.
1 pursing-davit, 22 inches long.
8 oar-holders.
1 tow-link, with hooks.
1 side-link, with eye.
1 towing-pin.
4 malleable iron pursing-blocks, with 5-inch wooden sheaves, and brass patent-roller bushings.
1 davit-guard.
2 pursing-cleats.
4 eye-plates for oar-holders.
2 eye-plates for leading-blocks.

18. DINGHY.

The *Dinghy* is an open, carvel-built, square stern, keel boat. It is built of seasoned white and grey oak and white swamp-cedar, fitted to pull four oars, fastened with copper; all fastenings are riveted over copper burrs on the inside. She is sloop-rigged, carrying a loose-footed sprit mainsail and jib, the latter tacking down to the stem-head.

The following are the detailed dimensions: Length over all, 17 feet; breadth, 5 feet; depth, 2 feet 1 inch.

Keel, of oak, $2\frac{1}{2}$ inches deep by $1\frac{7}{8}$ inches wide.

Stem, oak, sided 3 inches, molded $\frac{3}{4}$ inch back to $1\frac{7}{8}$ inches.

Stern-post, sided on bottom end 6 inches, tapered to $1\frac{3}{4}$ inches on top, bearded up on outside $1\frac{1}{4}$ inches to $1\frac{7}{8}$ inches.

Stern, oak, $1\frac{3}{8}$ inches thick.

Floors, oak, $1\frac{1}{2}$ inches by $1\frac{1}{4}$ inches, tapering at upper end to $1\frac{1}{8}$-inches.

Frames, white oak, steamed and bent to proper form, $1\frac{1}{8}$ to $1\frac{3}{8}$ inches at bottom and bilge, tapering at top to $1\frac{1}{8}$ inches, and spaced 12 inches from center to center.

Gunwales, oak, $1\frac{5}{8}$ inches by $1\frac{3}{4}$ inches.

Planking, topstreak of clear grey oak, $\frac{5}{8}$ inch thick; remainder of plank white swamp cedar, well seasoned, $\frac{3}{4}$ inch thick.

Ribband for thwarts, of oak, $1\frac{1}{2}$ inches by $\frac{3}{4}$ inch.

Stern-sheets and *thwarts*, of ash, $1\frac{1}{8}$ inches thick.

Thwarts, 8 inches wide. *Stern-sheets* vary in width from 9 inches to about 1 foot. There is a turned ash stanchion under the center of each thwart, to support it. Each thwart has two juniper knees on either end, to hold it in place.

Gratings.—There is a grating forward, flush with the bow-thwart, and one aft, under foot. They are made of ash and black walnut.

Backboard.—The backboard is made of black walnut, and has on it the vessel's name in gilt letters.

Footlings and ceiling.—There is a foot-board extending fore and aft, excepting in the bailing well. On either side of this the boat is ceiled up to the floor heads. The foot-board and ceiling has a fastening in each timber.

Stretchers.—There are four stretchers of oak, $1\frac{1}{4}$ inches square, to brace the feet against while rowing. The ends of these rest on cleats on the side of the boat.

Rowlocks.—There are four thin wooden cleats, two on each side, to receive the metal socket into which the rowlocks go. The rowlocks and sockets are made of polished gun-metal.

Ring-bolts and hoisting irons.—The ring-bolts and hoisting irons are of galvanized wrought iron, and riveted through the stem and stern-post.

Stem-band and Rudder-braces.—The stem-band and rudder-braces are made of brass.

Rudder.—The rudder is of oak, fitted with brass gudgeons and brass yoke.

Mast-clasp.—The mast-clasp is made of galvanized wrought iron, with eye on hinge, so that it can be unhinged from the thwart when it is necessary to take the spar down.

Boat-hook.—The boat-hook is of polished gun-metal, fastened to an ash pole 6 feet long.

Oars.—Of ash; ends of blades coppered to prevent splitting.

Spars.—Mast, of spruce, 16 feet long, with sheave at upper end for jib halyards. *Sprit*, of spruce, 16 feet long.

Sails.—The sails are made of boat drilling, and have the following dimensions: Mainsail luff, 13 feet; leach, $17\frac{1}{2}$ feet; head, 7 feet; foot, $11\frac{1}{4}$ feet; jib-leach, $10\frac{1}{2}$ feet; foot, 4 feet; luff, $11\frac{1}{2}$ feet.

Painter.—The painter is manilla rope, 25 feet long, $2\frac{1}{4}$ inches in circumference.

19. DORIES.

The dories are of the ordinary type used in the Bank fisheries, so far as form is concerned. The frames, stern, stem, and gunwales are of oak, the bottom of pine, and the planking of seasoned white swamp-cedar. They are fastened with galvanized wrought-iron nails, and built with four streaks instead of three as is the common rule. Each dory has three adjustable thwarts and three partition boards or kid boards of pine. The length is 15 feet on the bottom, and about 19 feet 4 inches over all.

Each boat is provided with the following equipment: three pairs of 9-foot ash oars; eighteen oak thole-pins; one bailing scoop; one white oak, brass-bound, 2-gallon water breaker; a painter, 5 fathoms long, of

2-inch manilla rope; stern becket of the same kind of rope. Bottom plug made to fit into $1\frac{1}{2}$ inch hole, provided with plug-line and becket; one mast, of spruce, 15 feet long; one spruce sprit 15 feet long, and one loose-footed sprit sail of white cotton drilling, having the following dimensions: Leach, $16\frac{1}{2}$ feet; luff, 13 feet; foot, 14 feet; head, 6 feet.

20. LIVE-CARS.*

There are three of these cars, each a duplicate of the others. The length on the bottom is 13 feet; the construction the same as that of the dories. The shape is like the dory, except that the stern is sharp, being a duplicate of the bow, and the beam and depth are somewhat greater in proportion to the length.

The frames, gunwales, stem, and stern-post are oak; planking, white cedar $\frac{9}{16}$-inch thick; fastening, galvanized iron. They are provided with chafe-ribbands from stem to stern on each side along the outside of gunwales.

Each car is fitted with a cover of heavy netting, made of four-cord marline, which fastens to brass screw-eyes underneath the gunwales, the eyes being placed six inches apart. The forward end of this net cover is so arranged that it can be quickly and easily loosened to admit fish.

There are six $\frac{7}{8}$-inch holes in the bottom and as many similar holes on each side of each car to admit a free circulation of water.

D.—APPARATUS FOR FISHING, COLLECTING, ETC.

21. BEAM TRAWL.

(Plates XV and XVI.)

The net and head-irons for the beam trawl were imported from Grimsby, England, and are of the usual pattern employed in the fisheries of the North Sea. They are intended to fit a 30-foot beam, and are smaller than those used on the larger class vessels which carry a trawl-beam of from 45 to 50 feet in length.

The head-irons serve the various purposes of weights to sink the net and beam, of runners to facilitate the passage of the apparatus over the

*The live-cars were built for the purpose of keeping alive cod and other fish which might be caught on trawl-lines. It was intended that they should be used in connection with dories, being held alongside of the latter while the lines were hauled in, so that the fish might be easily put into them.

It was found on trial, however, that they were difficult to manage in a rough sea, such as is commonly met with in winter, off the New England coast, where it was necessary to use the cars. Being full of water, and therefore heavy and loggy, they would bump heavily into the dories, and, when taken alongside the vessel, would frequently dive beneath her bottom as she rose on a sea, and were hard to handle and hoist on deck. After using them a short time, they were superseded by stout net bags, which proved eminently satisfactory and serviceable.

For other fishing, these boat-shaped live-cars are useful, and are found especially so for sea bass, scup, and lobsters.

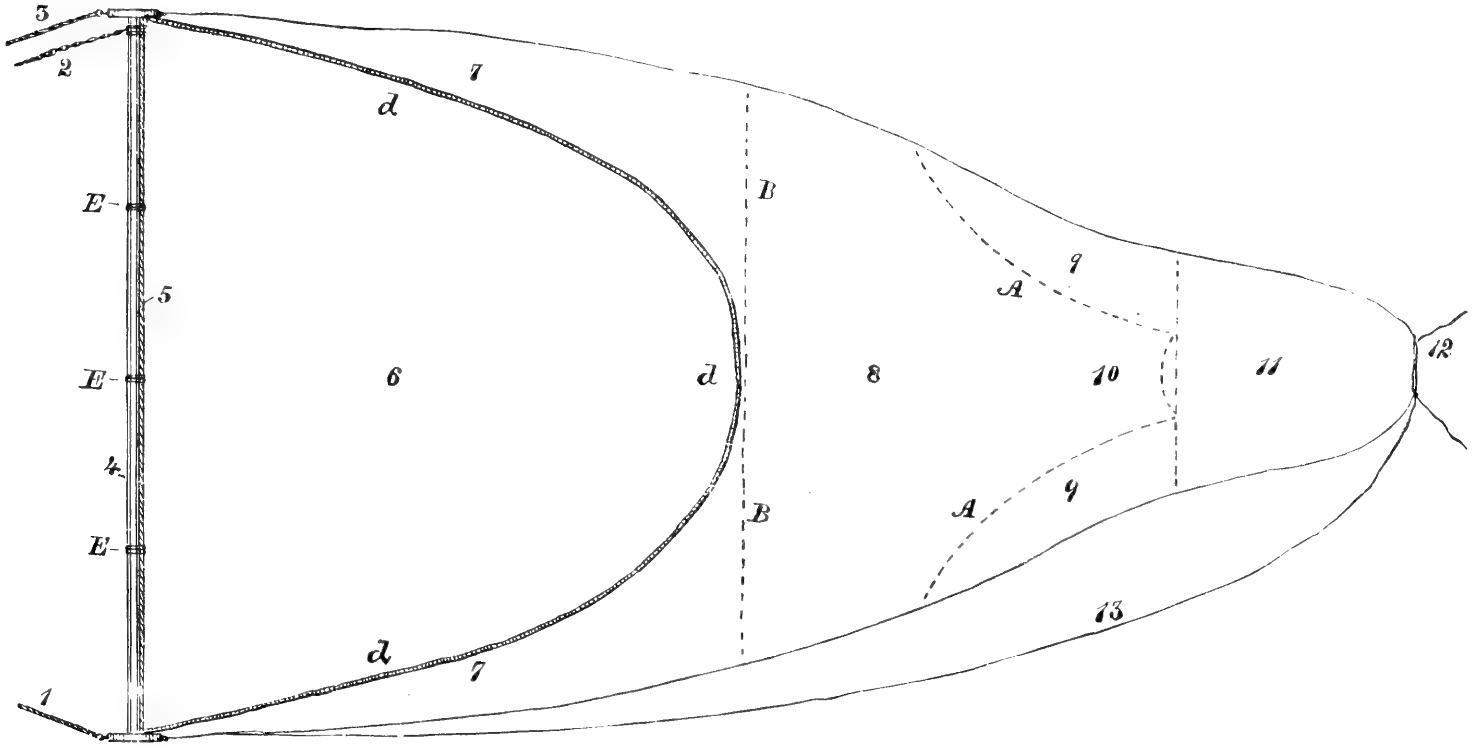


DIAGRAM OF BEAM-TRAWL.

1. Forward bridle.
2. Dandy bridle.
3. After bridle.
4. Beam.
5. Head line.
6. Square of net.
7-7. Wings.
8. Baiting on top, belly underneath.
9-9. Pockets.
10. Flapper.
11. Cod-end.
12. Poke-line.
13. Cod-line.

A, *A*. Where the net is sewed together to form pockets.
B, *B*. Where the square joins the baitings.
d, *d*, *d*. Foot rope.
E, *E*, *E*. Grommets.

Drawn by J. W. Collins.

ground, and of a support to keep the beam above the bottom and distend the mouth of the net.

The beam is of oak, 30 feet in length and 6 inches diameter. The appearance of the trawl, when rigged, and its several sections are shown in Plates XV and XVI.

The object of having a beam trawl of this size is that the utility of this form of apparatus for commercial fishing off our Atlantic coast might be fairly tested by the *Grampus*. Reference is made to Vol. VII, Bull. U. S. Fish Commission, pages 289 to 407, for information concerning the beam trawl and its use in European waters.

22. THE PURSE-SEINE.*

The purse-seine is similar to those used by the New England fishermen for the capture of mackerel. It is 150 fathoms long, as hung, and is 700 meshes deep, the mesh being 2 inches, stretch measure. The seine is composed of several sections. A small section in the middle termed the "bailing piece," which is 500 meshes long by 200 meshes deep, is made of number 20–12 twine. The rest of the bunt is made of number 20–9 twine. On each side of the bunt is a narrow strip 150 meshes wide by 685 meshes deep of number 16–6 twine. The wings are made of number 20–6 twine, each of them being 165 yards long in the web, and 685 meshes deep. There is a border along the lower edge of the wings 15 meshes deep made of number 20–9 twine.

The seine was tanned and then tarred to preserve it. The object of doing this was to prevent it from heating, which might be the case if tar only was used. It is hung in the usual manner. Small galvanized iron pulleys or purse-blocks† are used on the bottom instead of rings, for the purse-line to reeve through.

The following are the approximate weights of the various items entering into the construction of the seine, exclusive of the purse-blocks:

	Pounds.
Web	350
Corks, 1,500 No. 2	135
Manilla rope	75
Purse-rope	125
Leads on foot	50
Tar	400

This makes a total of 1,135 pounds. If we add to that the probable weight of the purse-blocks, about 50 pounds, it will make a total of 1,185 pounds. The net, when it is put into the water and wet through, will weigh from 400 to 600 pounds more.

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*The purse-seine used on the *Grampus* was orginally made for the *Albatross*. It was not, however, used by the latter vessel, and when the *Grampus* was built it was transferred to her by the Commissioner.

All of the twine is hawser laid twine, made of the best Sea Island cotton.

† These are the invention of Captain George Merchant, jr., who made the seine.

23. DREDGE.

The dredge used on the *Grampus* is the ordinary type employed by naturalists, a pattern which was long since adopted in Europe and America. It is of the size commonly called "boat dredge," being smaller than the "ship's dredge," from which it differs only in dimensions. It is composed of an iron frame to which is attached a net bag, the latter being covered by a bottomless canvas shield to protect the net from injury by chafing on the sea bottom when being towed.

The frame consists of two jaws joined together by an iron stud at each end, which is welded to the jaws, the latter being so arranged that they flare at an angle of about 12 degrees.

The frame is 18 inches in length, 5½ inches inside, and 7½ inches between the edges. The jaws are 2½ inches wide and one-half inch thick; the bridles are 16 inches long.

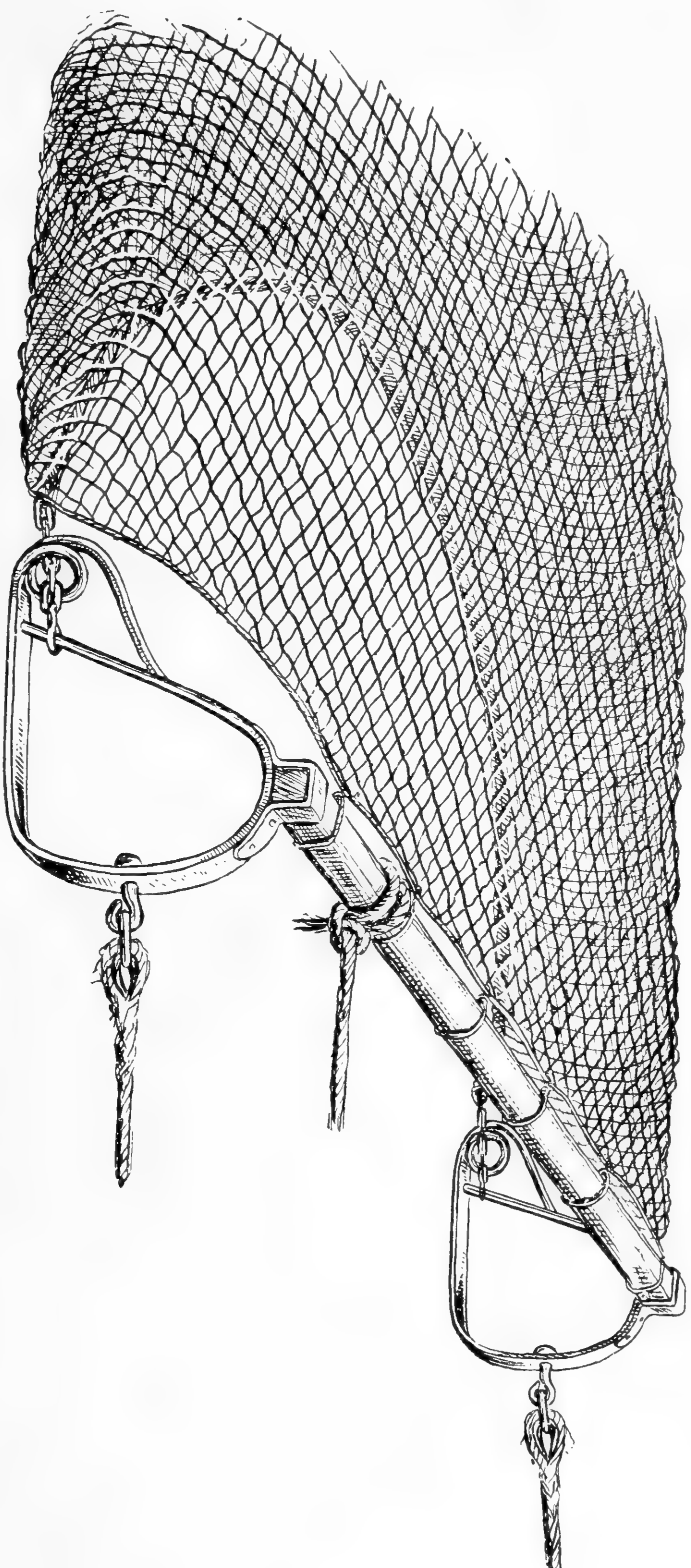
The net is 2½ feet long, has 2 or 3 meshes to the linear inch, and is closed at the lower end, so that it is approximately conical in form. The net is fastened to the iron frame by a lacing that passes through a series of holes in the back of the jaws. The canvas shield which protects the net from chafing is laced through the same holes.

The towing-line is bent to one of the bridles only, the other bridle being held by a smaller piece of line, or by a seizing, to the tow-rope or the bridle it is fastened to. This arrangement is necessary to prevent the loss of the apparatus when it comes in contact with stones or other obstructions on the bottom, since the seizing will break under a heavy strain and thus allow the dredge to be pulled up end on, in which position it is most liable to free itself.

24. "GRAMPUS" TOWING-NET. (See fig. 4.)

The large surface towing-net used on board of the *Grampus* was devised by the writer with the object of securing an apparatus which would be convenient to stow away on board the vessel, and one which would also prevent the escape of such animals as entered it. It consists of a hoop-shaped frame made of ⅝-inch iron, jointed in the middle so that it may be folded together for convenience in stowage. The diameter of the hoop is 5 feet. The net, the mouth of which is laced to the hoop by a roving, is cone-shaped, with an interior funnel-shaped net that forms a pocket at the lower end for preventing the escape of such animals as enter the apparatus. The lower end of the net is 9 inches broad when open, and is so arranged that it can be tied up with a string that passes through the meshes on the border, and is intended to be unloosed to let out the contents. The mesh of the net is ¾-inch, stretch measure, next the hoop, tapering to ½-inch at the lower end or apex of the cone. The two lower rows of meshes are made of heavy twine to stand the strain of being tied up. When in use a rope bridle is attached to the hoop with a thimble in the center for the towing-rope to bend into.

PLATE XVI.



TRAWL-HEADS, BEAM, MOUTH OF NET, ETC. SHOWS HOW BRIDLES ARE ATTACHED.

25. CIRCULAR HAND SIEVES.

Hand sieves are used on the *Grampus* for washing such material as is brought up in the dredges.

"In working over small quantities of material, especially in search of the smaller organisms, circular hand sieves, in nests, have been employed by the United States Fish Commission, of the same general pattern as those described by Sir Wyville Thomson, in Depths of the Sea. These have usually been constructed with wooden frames, in nests of three to five sieves. Quite recently the wooden frames have been

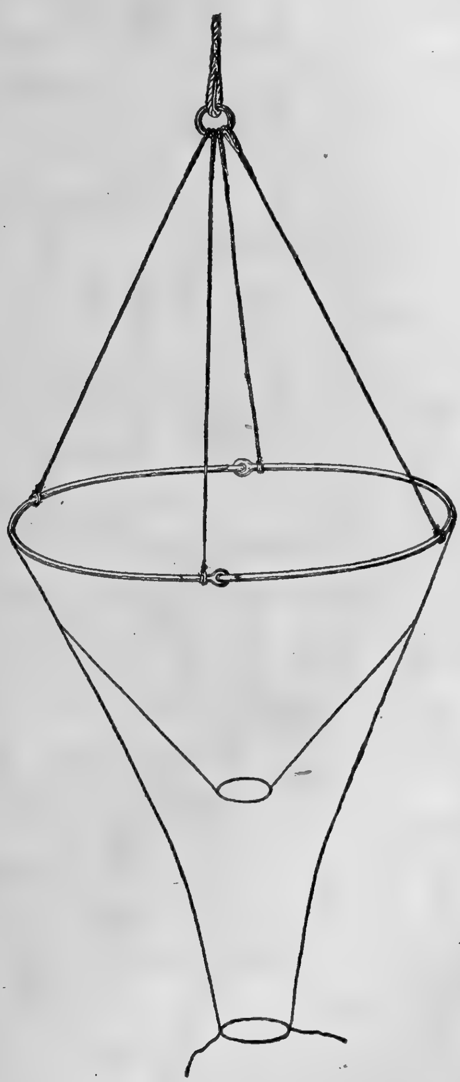


FIG. 4.—Grampus towing-net.

changed for others of galvanized sheet-iron, with good results. The old style of wooden frames, after a little use, lose their regular shape, will not nest snugly, and the beading, which runs above the wire bottom, is constantly becoming loosened and catching and concealing many small objects. The metal sieves are made in nests of three or four, one of the former and smaller nests being exhibited. In this, the lower sieve measures 10 inches in diameter in the inside, the middle sieve $9\frac{3}{4}$ inches, and the upper one $9\frac{1}{2}$ inches, the difference between these diam-

eters being equal to about the thickness of the iron. The lower sieve has a height of $3\frac{1}{4}$ inches, the middle sieve $2\frac{3}{4}$ inches, and the upper sieve $4\frac{3}{4}$ inches. In the lower sieve the netting is raised three-fourths of an inch above the bottom, but in the other two it is flush with it. The lower netting is of copper, with 38 meshes to the linear inch, and on account of its lightness is strengthened underneath by a cross framework of moderately heavy wire; the second netting is also of copper wire, with 8 meshes to the linear inch, and the upper is of galvanized iron wire, with two meshes to the linear inch. The several sieves are smooth and without angular projections on their inner surfaces, and fit snugly together. They are prevented from nesting too deeply by means of a wire bent in around the outer sides of the two upper sieves, $1\frac{1}{2}$ inches above the bottom. This affords interspaces of about an inch between the nettings of the several sieves. The rims of the sieves are strengthened with wire, and the handles, which stand upright, are of such lengths that when the sieves are nested they reach to the same height, and can be grasped together. The nests of three sieves may be worked in a large bucket of water, but those of four sieves are larger, and require at least a small tub for their use."—Rathbun, Bull. 27, U. S. Nat. Mus., 1883, 576.

26. TANNER SOUNDING MACHINE.

This machine, which is the invention of Lieut.-Commander Z. L. Tanner, U. S. N., was originally designed by him for service on board of the U. S. Fish Commission steamer *Fish Hawk*, where it was used in depths not exceeding 800 fathoms. On the *Grampus* it is not used in depths beyond 600 fathoms. It is located, when in use, a little forward of the starboard main rigging, but owing to the fact that it is liable to injury in that position it is generally kept below, excepting when required for sounding. This apparatus has been fully described and figured by the inventor in the annual report of the U. S. Fish Commission for 1881, pages 22 to 24, inclusive, and in the annual report for 1883, pages 57 to 63, inclusive. Reference is therefore made to those descriptions of its construction, use, and accessories.

27. THERMOMETERS.

The Miller-Casella and Negretti and Zambra deep-sea thermometers are used on the *Grampus*, as on all other vessels of the Commission, for taking temperatures of the sea. For full details of these instruments and their use reference is made to the annual report of the U. S. Fish Commission for 1881, pages 25 to 28; also annual report of the Commission for 1883, pages 71 to 77.

28. ADDITIONAL APPARATUS.

In addition to the specially noticeable forms of apparatus, which have been mentioned in greater or less detail, there is an extensive outfit for fishing and collecting, for laboratory equipment, for the purposes of navigation, and for medical outfit, etc.

a. Fishing lines rigged for use.

Skates halibut trawl lines (each skate rigged with 150 hooks)	8
Skates cod trawl lines (each rigged with 500 hooks)	11
Tubs haddock trawl lines (each rigged with 500 hooks)	5
Cod hand lines for boats, 3 pound leads	5
Cod hand lines for boats, 4-pound leads	5
George's bank cod hand lines, 7½-pound leads	10
Pollock hand lines, 3-pound leads	16
Bluefish lines for trolling	6
Sea-bass lines	10
Squid lines	3
Whiting lines	10
Mackerel lines	42

Besides the lines rigged for use, there is on board a quantity of spare unrigged lines, hooks, etc., to replace gear which may be lost or rendered worthless by use. There is also much miscellaneous material used in fishing. The kinds and quantities of this unclassified apparatus commonly kept in reserve or for current use, is as follows:

b. Miscellaneous apparatus used in fishing.

Anchors, Chester's folding net	1
Anchors, Chester's folding trawl	16
Baskets, fishing bait	6
Blocks, double, 12-inch wooden, for handling beam trawl	2
Buoys, halibut trawl	8
Buoys, cod trawl and net	12
Buoy-lines, fathoms	3,450
Compasses, dory	3
Fish forks	4
Fish pews	2
Gaffs, deck, cod	5
Gaffs, dory, cod	3
Gaffs, iron, halibut	10
Gob-sticks, wooden	3
Guns, whale	1
Harpoons, whale	1
Harpoons, swordfish	2
Harpoons, porpoise	1
Hooks, cod, hand line, No. 10, center draught ..... dozens	42
Hooks, cod, hand line, No. 12, center draught ..... dozens	12
Hooks, cod trawl, No. 14, center draught, eyed ..... dozens	144
Hooks, haddock trawl, No. 16, center draught, eyed ..... dozens	132
Hooks, haddock trawl, No. 17, center draught, eyed ..... dozens	204
Hooks, halibut trawl, Kirby-bend, No. 6,283 ..... dozens	36
Hooks, mackerel ..... do	24
Hooks, miscellaneous, small ..... do	24
Hooks, shark ..... each	4
Hurdy-gurdies, or trawl winches, galvanized	3
Ice tongs	1
Jigs, mackerel	20
Jigs, squid	10
Knives, bait	7
Knives, codfish splitting	3
Knives, codfish throating	3
Knives, haddock ripping	2
Knives, halibut	4
Knives, mackerel splitting	5
Lances, explosive bomb	15
Lances, whale	1
Leads, fishing, 1¼-pound	6
Leads, fishing, 4-pound, Lothrop's	3
Leads, fishing, 7½-pound, Lothrop's	4
Leads, sounding, 8-pound	2
Leads, sounding, 10-pound	2
Leads, sounding, 12-pound	2
Leads, sounding, 16-pound	2
Leads, sounding, 25-pound	3
Lines, cod, hand lines ..... skeins	10
Lines, cod trawl, ground ..... do	52
Lines, cod trawl, ganging ..... do	10
Lines, haddock trawl, ground ..... do	50
Lines, haddock trawl, ganging ..... do	24
Lines, halibut trawl, ground ..... do	72
Lines, halibut trawl, ganging ..... do	10
Lines, snapper ..... do	6
Line, whale, 1¾-inch manilla rope, fathoms	150
Mill for grinding toll-bait	1
Mold for mackerel jigs	1
Nippers, woolen, hand ..... pairs	15

Pewter, for mackerel jigs..pounds..	5
Pulpit, swordfish	1
Rasps, for making jigs, etc	1
Reels, small fishing line	12
Scoops, bait	4
Scoops, ice	1
Sinkers, lead, for small fishing lines.	24
Sinkers, lead, for net lead line, pounds	150
Shovels, ice, salt, etc	4
Sling-ding spreaders, for cod hand-line gear	6
Splicers, iron line	5
Swivels, snood	6
Swivels, slot	13
Swivels, hawse	6
Swivels, buoy	8
Trawl rollers, patent	3
Trawl-warp (Italian hemp, $3\frac{1}{2}$ inches)..fathoms..	300
Tubs, dressing, fish	3
Tubs, gib	
Twine, manilla, lobster..pounds..	12
Weights, purse seine	2

c. Gill-nets and seines.

Kinds.	No.	Length.	Depth.	Size mesh.	Twine.
		Fath.	*Fath.*	*Inches.*	
Trammel nets	2	15	$2\frac{1}{2}$	{ 2 { 6	35-3 12-16
Mackerel gill-net	1	30	$2\frac{1}{2}$	$3\frac{3}{4}$	16-6
Do	1	30	$2\frac{1}{2}$	3	16-6
Do	1	30	$2\frac{1}{2}$	$2\frac{1}{2}$	16-6
Menhaden gill-net	1	15	2	$3\frac{1}{2}$	16-6
Do	1	15	2	$2\frac{1}{2}$	16-6
Herring gill-net	2	20	$2\frac{1}{2}$	$2\frac{3}{4}$	20-6
Do	2	20	$2\frac{1}{2}$	$2\frac{1}{2}$	20-6
Cod gill-net	1	100	2	7	40-10
Do	1	100	2	8	40-10
Capelin seine	1	40	$2\frac{1}{2}$	{ $0\frac{3}{4}$ { $2\frac{1}{2}$	12-6

d. Dip and scoop nets.

Kinds.	No.	Diameter of bow.	Length of handle.
		Inches.	*Feet.*
Dip-net for mackerel purse seine	1	29	11
Dip-nets for removing fish from well	2	20	13
Scoop-nets with round bows	2	15	5

E.—LIBRARY

The library contains over one hundred volumes, but of necessity (for lack of space) is limited to such works as are of special importance for reference. They relate chiefly to the fisheries, science, and navigation. Among them are twenty-seven volumes published by the U. S. Fish Commission, thirty-eight volumes issued by the Smithsonian Institution and National Museum, and twenty-seven relating to navigation, nautical astronomy, coast lights, etc.

F.—LABORATORY OUTFIT.*

Acid, muriatic.
Acid, nitric.
Acid, picric.
Alcohol.
Arsenic.
Axe.
Bags, canvas (collecting game bags) (3).
Boxes, wooden, assorted (in nests).
Brushes, wire, for cleaning shot-guns (2).
Barrels, fish.
Case of taxidermist's instruments (1).
Cartridges, rifle, ball, 50 caliber.
Cartridges, revolver, ball, 38 caliber.
Cartridges, shot-gun.
Cartridges, small collecting gun.
Chisels, cold.
Chisels, mortising.
Claw bar, iron (1).
Cleaning rods, for shot-guns (2).
Cleaning sticks, for shot-guns (3).
Cloth, cheese, cotton.
Corks, rubber, assorted.
Cotton batting.
Crimpers, for loading cartridges (2).
Cutters, wire (1).
Decapping pins (3).
Dishes, assorted, glass and earthenware.
Drills, assorted.
Extractors (rings), for extracting cartridges from shot-guns (3).
Files, assorted.
Forceps (2).
Grindstone (1).
Gun covers, canvas (3).
Hammers, riveting (1).
Hatchet (1).
Ice-pounders, or breakers (2).
Ice-tongs (1).
Jars, with corks, assorted sizes.
Jars, butter, 2-pound, 4-pound.
Jars, fruit, 1-pint, 1-quart, 2-quart.
Knives, dissecting (2).
Ladles, lead (1).
Loaders, shot-gun (2).
Needles, sewing.
Needles, taxidermist (3).
Nets, surface, silk bolting cloth.
Nets, surface, linen scrim.
Nippers, steel.
Paper, straw.
Paper, manilla.
Pans.
Plaster for molds, casts, etc.
Powder, small-arm.
Powder chargers for loading cartridges (2).
Recappers (2).
Revolver, 38 caliber (1).
Rifles, Springfield, 50 caliber (2).
Rifle-covers, canvas (2).
Rule, common 2-foot (1).
Scissors, common.
Scissors, taxidermist's (1).
Shot-chargers (2).
Shot-gun, small, single-barrel, collecting (1).
Shot-gun, double-barrel, 12-bore (2).
Shot-gun, double-barrel, 10-bore (1).
Soldering iron (1).
Solder, soft.
Spades, common (1).
Sponges.
Syringe, rubber, injecting (1).
Tanks, copper, alcohol, 16-gallons (2).
Tank boxes (2).
Twine.
Tags.
Vials, homœopathic, assorted.
Vise, amateur swivel (1).
Vise, hand (1).
Wads, for shot-guns.
Weighing balance (1).
Wire, iron, annealed.
Wire, steel, music No. 21.
Whetstones (6).

* The list given under this head embraces such material as may properly be included in the outfit for making collections for scientific purposes and for preserving and storing them; it is additional to the fishing and fish cultural apparatus mentioned elsewhere, which also to a considerable extent constitutes part of the laboratory equipment. To insure convenience of reference the articles have been alphabetically arranged, though this method interferes with any such classification as would naturally be followed if the special uses of the material received primary consideration.

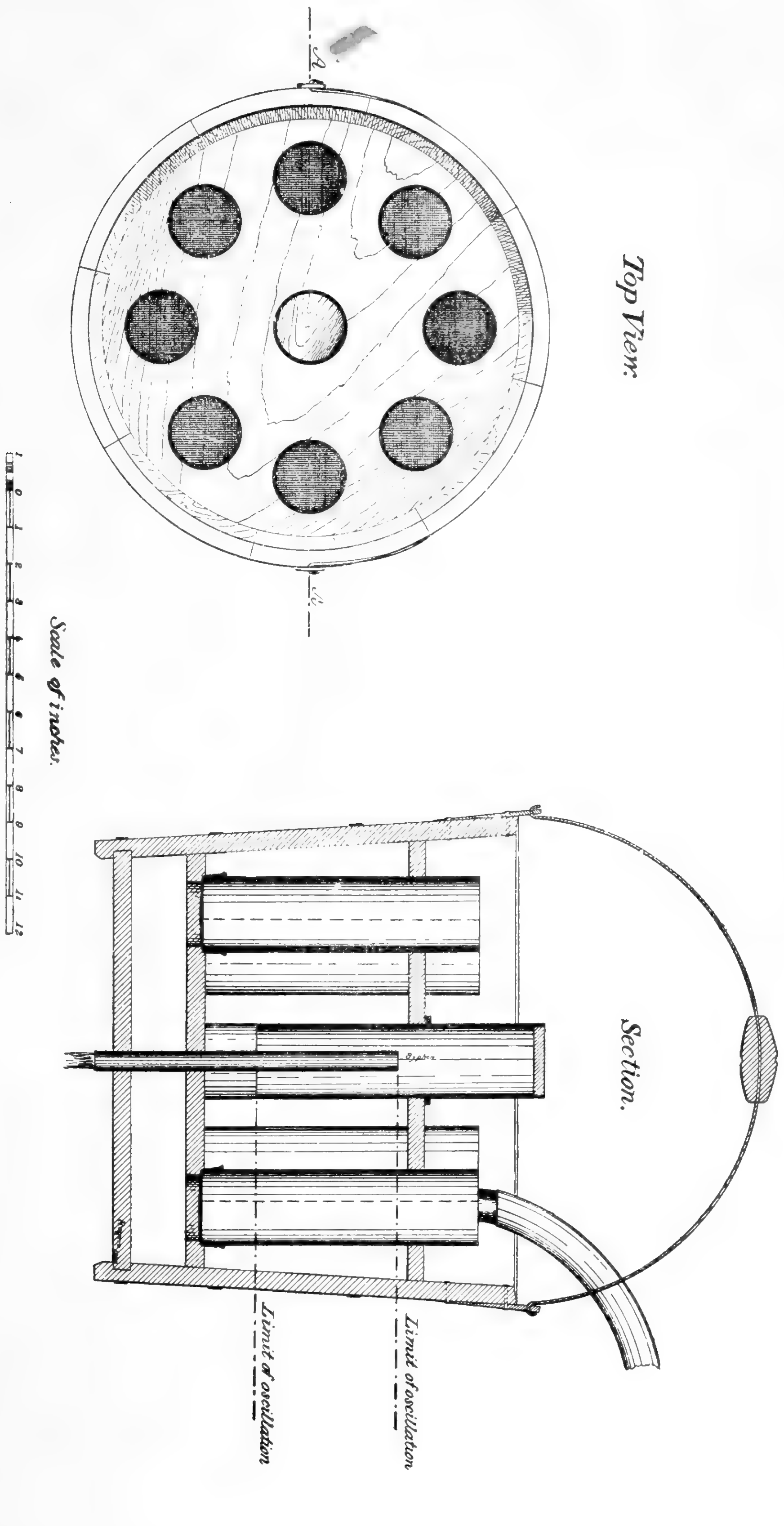
There is so much variation in the quantity of some of the things that the enumeration of the amounts has been omitted in many cases.

G.—MEDICAL OUTFIT.

The medical outfit is quite elaborate for a small vessel, and besides the articles enumerated under the head of "Medical Stores," includes two publications, namely; "Manual of Medicine" (Hartshorne) and "Hints for Emergencies," by Dr. J. H. Kidder.

The following is a list of medical stores:

Powdered gum arabic.
Acetic acid c. p.
Nitric acid c. p.
Carbolic acid, crystallized.
Muriatic acid c. p.
Citric acid, crystallized.
Alcohol, 95 per cent.
Alum.
Extract belladonna.
Castor oil.
Blue pills.
Brandy.
Borax.
Camphor.
Fly-blister plasters.
Capsicum.
Chloral.
Collodion.
Chloroform for external use.
Chloroform for inhalation.
Compound cathartic pills.
Aloin pills.
Salicylic acid pills.
Cosmoline.
Cocoa butter.
Ether (Squibbs).
Flax-seed meal.
Extract gentian.
Extract ginger.
Tartrate iron and potassa.
Iodoform.
Tincture of iodine.
Liquor sulphate of iron.
Tincture chloride of iron.
Syrup of ipecac.
Laudanum.
Licorice.
Licorice, fluid extract.
Lime.
Magnesia.
Sulphate of morphia.
Mercurial ointment.
Olive oil.
Naphthaline.
Sweet spirits of niter.
Paregoric.
Bromide potassium.
Iodide potassium.
Huxanis tincture.
Quinine sulphate.
Quinine pills, 3 gross each.
Nitrate silver, crystals.
Nitrate silver, fused (L. C.).
Soap liniment.
Bicarbonate soda.
Syrup of squills.
White sugar.
Sulphur.
Oil of turpentine.
Whisky.
Carbonate of zinc.
Sulphate of zinc.
Mustard plasters, No. 1.
Stomach pump.
Pocket case.
Goulard's lotion.
Bandages.
Lint.
Urinometer.
Rubber tracheotomy tube.
Tourniquet.
Tape measure.
Wire ligature, silver.
Cotton suspensory bandages.
Belladona plasters.
Alcock's porous plasters.
Benson's capcine plasters.
Plaster skins.
Silk ligatures.
Adhesive plasters.
Isinglass.
Small sponges.
Small syringes.
Absorbent cotton.
Self-injecting syringes.
Binders' boards.
White wrapping-paper.
Oiled muslin.
Bougies.
Black rubber tubing.
Twine.
Spatulas.



PLANS OF McDONALD'S HATCHING-BUCKET.

Drawn by E. I. Rogers.

Scissors.
Sealing-wax.
Pill-boxes.
Table-spoons.
Tea-spoons.
Pill tile.
Labels.
Gallipots.
Corks.
Hard rubber funnels.
W. W. mortar and pestle.
4-ounce measure (1-1 dram measure).
Spirit lamp.
Spirit stove.
Tumblers.
Wine glasses.
Assorted phials.
Plaster of Paris.
Bottle clasps.
Scales and weights, "Navy pattern."
Dispensing bottles with glass labels.

H.—FISH-CULTURAL AND TRANSPORTING APPARATUS.

29. COLLINS' EGG-PAN (see fig. 5).

This pan was devised by the writer for collecting fish-eggs at sea. It was found in practice that the ordinary tin pan commonly used for collecting fish-eggs on shore was unfit for collecting eggs when it had to be used on board of boats and vessels in a sea-way, where there was much motion, and also had to be passed from boats to vessels, or *vice versa.*

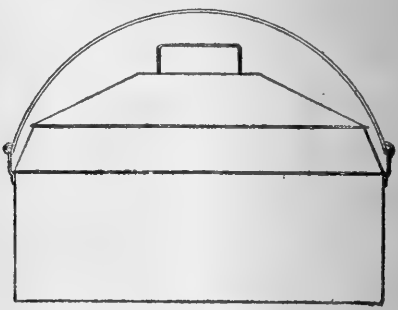


FIG. 5—Collins' egg-pan.

The pan is oblong in form, with a tumble-in top, provided with an iron bail and tin cover, the latter preventing the loss of eggs from slopping out and the former facilitating the handling of the apparatus in the boat. The pan is 18½ inches long, 10¼ inches wide, and 8½ inches high exclusive of the cover. It is made of tin and covered with asphaltum inside to prevent corrosion from contact with the sea-water.

30. McDONALD'S HATCHING BUCKET.

(Plates XVII and XVIII.)

This device was invented by Col. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, for the purpose of keeping alive, developing, and hatching (if necessary) such floating eggs of pelagic fishes as might be taken on board the *Grampus* in the towing nets.

The device consists of an ordinary iron-bound pine bucket, provided with an iron bail and fitted inside with two perforated wooden diaphragms; one of these is placed near the top of the pail and the other about 1½ inches from the bottom, each resting on a wooden flange screwed to the inside of the bucket. There are nine holes in each diaphragm, one of them being in the center and the others arranged in a circle around it. These holes are large enough to receive glass tubes 2 inches in diameter and 7 inches long, these being the same as those

commonly used on argand burners. The holes in the lower diaphragm are made with flanges so that the glass tubes can rest upon them. When in use, the eight tubes around the side of the bucket have their lower ends covered with cheese cloth, so that, while the escape of eggs will be prevented, there is no hindrance to the proper circulation of water. In the center of the bucket is placed an automatic syphon so arranged that when it is connected with a hose bringing water into the bucket, it will break the flow when it has reached a certain height, and will thus cause a regular ebb and flow motion, or "tide motion," as it is commonly called.

The bucket is located in the laboratory of the *Grampus*, and is connected by rubber hose with the well, from which an ample supply of water is obtained, while the surplus water is carried by another hose into the bilge of the vessel and taken out with the bilge pumps.

When floating eggs are obtained, one or more buckets are put in operation, and the eggs are immediately transferred into the glass tubes. They can be kept in a condition of development until the vessel reaches one of the coast stations, when the eggs are put into hatching-troughs on shore.

The buckets used are 10 inches high, 13 inches in diameter at the top, and about $11\frac{3}{4}$ inches diameter at the bottom, the staves being three-quarters of an inch thick. They are coated on the inside with asphaltum.

31. MISCELLANEOUS MATERIAL.

Buckets, wooden, (6).
Dippers, tin (3).
Hatching-jars, Chester's (4).
Pans, tin (6).
Tubs, wash, wooden (3).
Tubes, brass (1).

I.—METHODS OF FISHING, DREDGING, ETC.

32. FOR LIVE CODFISH.

As has been mentioned, an important part of the work performed by the *Grampus* is the collection of living gravid cod, pollock, and other species of *Gadidæ* for the marine hatcheries on the New England coast. The season extends from October to May, and the method of fishing varies with season and species.

The grounds resorted to are chiefly about No Man's Land, on Nantucket shoals, and off Gloucester, in Massachusetts Bay. Sometimes the cod grounds in Ipswich Bay and on the shoal grounds east of Cape Ann are visited.

a. HAND-LINE FISHING.

In the fall the cod which gather on the grounds near No Man's Land, to the south and east of Nantucket, and on the small rocky patches in Massachusetts Bay, can most readily be taken with hand-lines. The

pollock, which frequent Massachusetts Bay in autumn (at which season they are gravid), are also caught with hand-lines specially prepared for that purpose.

The vessel is first anchored so that she will "tail" on to a shallow rocky patch (if fishing off Cape Ann), when sufficient cable has been payed out. It requires skillful handling to anchor so that she will "swing" exactly over a shoal, which is usually of such small dimensions that its location has to be determined by leading marks on the land.

The lines are immediately put out, part of the crew usually fishing from each side of the vessel. As fast as fish are hauled in they are carefully unhooked and dropped into the well, where they remain until the vessel returns to the hatching station. Sometimes the fish are kept in the well several days. If any of the fish die they are immediately removed, so that they will not decompose and contaminate the water in the well.

It is frequently found advantageous in Massachusetts Bay to send part of the crew out in dories to fish at a little distance from the vessel. In such cases the men take with them net bags of coarse twine (elsewhere referred to), which are hung to the outside of each boat to receive the fish. If the wind is blowing fresh, as is commonly the case, each dory has a line leading to the vessel, by which it can be hauled alongside, since it is not practicable to row a boat against a stiff breeze and tow the net-bag containing the fish. As soon as a dory reaches the schooner the bag is hoisted on board and its contents are dumped into the well.

On the grounds off Nantucket and No Man's Land all the men fish from the vessel's deck for cod, as a rule. Occasionally it is found desirable to "fish at a drift," the vessel being hove to under mainsail and foresail, and all hands fishing from the weather side. But this is seldom done.

When pollock fishing, it is generally necessary to anchor with the "pollock fleet," which gathers in a cluster on a shoal where fish abound, the vessels lying close together, swinging with the wind, and usually with mainsails set. The crew fish from the deck, and sometimes pollock are so numerous and so eager to bite that they come near the surface and may be rapidly caught.

They are quickly unhooked and put into the well. But it is specially difficult to keep this species alive, owing to the fact that its swim bladder (sound) and the membraneous lining of its gill covers, etc., become easily inflated with air, which prevents it from keeping under water. It will not live well either if crimped.

b. Trawl-line fishing.

The vessel is kept under sail when trawling, and generally "flying-sets" are made, though occasionally it is found most advantageous to set the trawls one day and haul them the next.

The lines are baited and all ready to set before the vessel reaches the fishing ground. As soon as she arrives at the desired position the dories (with the lines and other necessary gear in them) are hoisted out, the vessel stands along, dropping the boats about 100 to 200 fathoms apart. Immediately on leaving the schooner the men proceed to set the gear, usually running the lines to leeward, unless the direction of the current makes it necessary to set across the wind.

As soon as the trawls are out the vessel runs down and shoots to, to deaden her way, alongside of each boat, which comes on board and is hoisted on deck or left to tow astern, as circumstances seem to dictate. As soon as all the dories are picked up the schooner beats back to the weather-buoys, near which she continues to jog back and forth on opposite tacks, with head-sails to windward, until the time arrives to haul the lines. She then stands along close to windward of the buoys, and a dory is let go at each. As soon as this is done she tacks and jogs again with head-sails to windward.

The men promptly begin hauling. As soon as the buoy line and first anchor are in, they hang the fish-bag over the boat's side, and then begin to haul in on the trawl-line. The fish are quickly and carefully unhooked and put into the bag, where they are kept until the lines are all in. An oar is then held up by the men on the dory as a signal to the officers who are closely watching the boats from the vessel. The latter then steers for the boat, and going a little to leeward shoots to close alongside so that a line can easily be thrown. A stout strap is put around the mouth of the fish-bag, which is quickly hoisted on board and its contents emptied into the well.

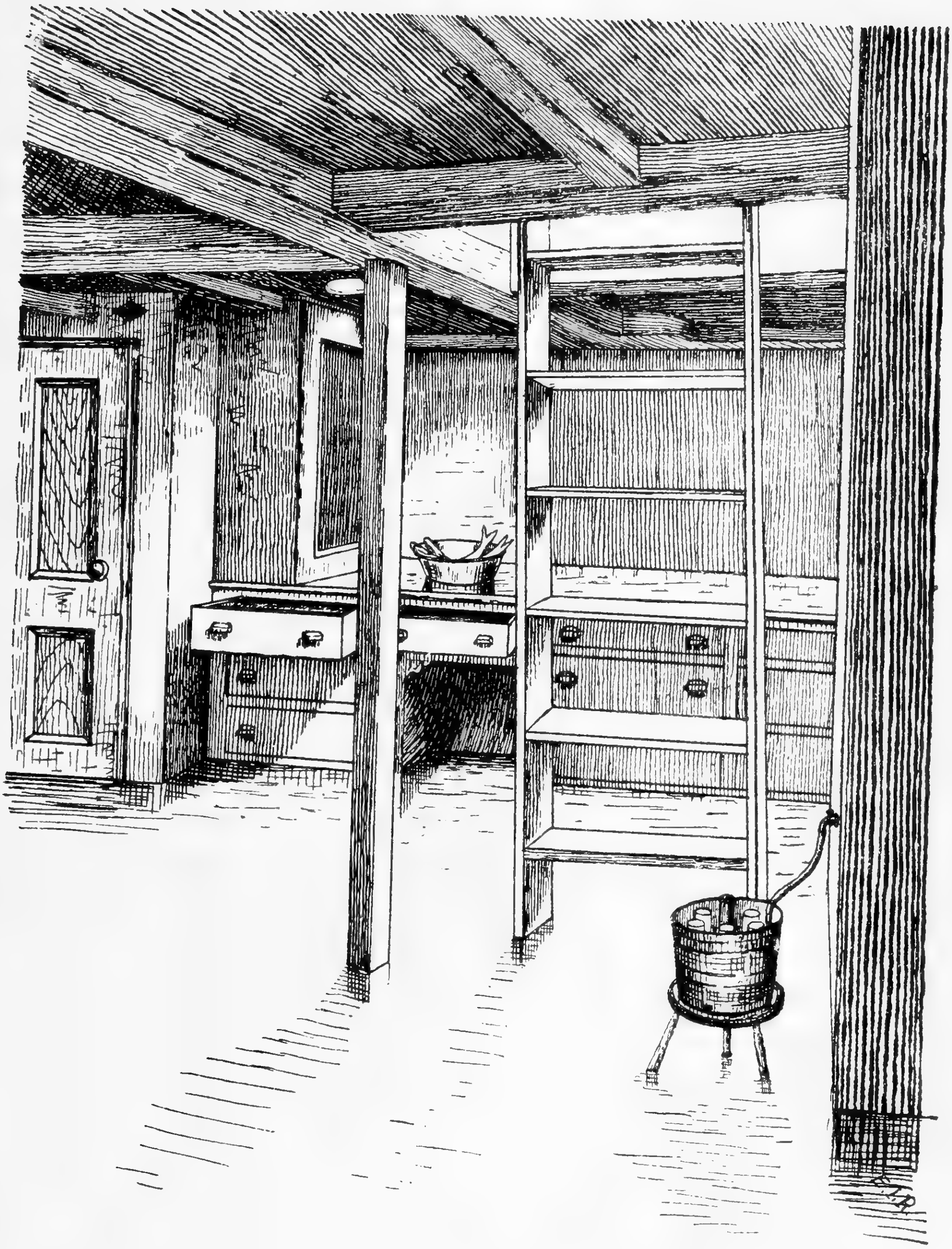
After all the dories have been picked up in this manner the vessel steers for the harbor unless the lines are to be set to remain out over night. When this is done a "second set" of lines are baited and made ready beforehand, and as soon as the hauling is completed these are run out in the manner already described. Care is observed to note the bearings of headlands, or the "marks" by which the location of the lines can be definitely determined when the vessel again goes for them, which may not be for several days, because of stormy weather.

c. Removing fish from the well.

Sometimes the fish are taken from the well on the same day they are caught, but generally this can not conveniently be done, either because the vessel does not return to the hatching station until she has fished several days, or it is most expedient to wait until a storm (which occurs frequently enough in winter) keeps her in port.

The fish are taken from the well with long-handled dip-nets. The peculiar shape of the well makes it possible to reach any part of it without difficulty. But after the majority of the fish are dipped out those remaining grow very shy and hard to catch.

As they are taken out each fish is examined to ascertain if milt or



VIEW IN LABORATORY OF GRAMPUS, WITH MCDONALD'S HATCHING-BUCKET IN OPERATION.

Drawn by E. I. Rogers.

eggs can be obtained. Those that are ripe are spawned, and then they are put into the live cars with the others, since the cod develops only a portion of its eggs at once.

33. FOR LIVE HALIBUT.

Trawl-lines are the only form of apparatus used to catch halibut for the purpose of taking them to the hatcheries alive. These are set "flying," while the vessel remains under sail. The operation is similar to that already described, with the exception that the depth of water in which the lines are placed is often from 100 to 300 fathoms. When practicable, the trawls are hauled on board of the vessel, which is maneuvered to facilitate the work. In the latter case the halibut are carefully lifted over the side, unhooked, and put into the well.

34. MACKEREL.

a. TOLL BAIT AND HAND-LINES.

In the course of the investigations made by the *Grampus* to ascertain the movements of mackerel during their migrations, and their whereabouts in other localities where they have been sought, the system of tolling them, for capture with hand-lines, has been frequently adopted. By this method the vessel is hove-to on the starboard tack, with the headsails hauled down, the mainsail guyed out, the fore-sheet eased off so that the sail will not stand full, and the helm put hard down. In this way the vessel makes a square drift to leeward. Ground bait or "stosh" of menhaden, herring, or mackerel is then thrown out systematically, as was formerly the custom pursued by the hook-and-line mackerel fishermen. This is generally continued from forty-five minutes to an hour, then if the mackerel do not "rise" it is assumed that they are not in the locality or are disinclined to take bait. The vessel is therefore got under way again, and proceeds to a new locality. The hand-lines used are the ordinary mackerel lines and jigs commonly employed in the hook-and-line mackerel fishery when that method was in vogue for commercial fishing. While the vessel is drifting these are thrown out on the weather side, so that in case any mackerel are tolled up they are liable to take the bait on the jigs.

b. GILL-NETTING.

In order to trace the movements of migratory species such as the mackerel, menhaden, alewife, etc., gill-nets are frequently set at night when the vessel is cruising at sea in the regions crossed by the pelagic fishes. When nets are to be set the vessel is hove to, according to the force of the wind, either under her mainsail alone or under her mainsail and foresail as she would lay to for catching mackerel. The nets are then payed out on the weather side, and the nearest one to the vessel is usually 40 to 60 fathoms distant, being attached to the end of a

stout manilla warp called the net-swing, that is commonly made fast near the middle of the schooner somewhere about the mainmast. The nets may be set at different depths, according to the judgment of the commanding officer, or the person having charge of the investigation, so that while the upper edge of some of them may be on a level with the surface of the water others may be sunk from 5 to 10 fathoms deep.

The nets are sometimes hauled in the night, but quite as frequently are left out until morning. Generally, the crew are able to pull them in, hand over hand, without difficulty, but if this can not be done the net-swing can be taken through a block and led to the windlass, where more purchase can be obtained for heaving it in.

c. SEINE.

For obtaining mackerel for the purposes of propagation, the purse-seine is the best form of apparatus to employ, since, if a school of fish can be found, they may be surrounded and quantities of them dipped alive into the well, where they can be kept until transported to one of the coast hatching-stations. The method of catching mackerel with a purse-seine on the *Grampus* is precisely similar to that adopted on board of the vessels employed in the purse-seine mackerel fishery. Briefly stated, it consists of keeping a sharp lookout from aloft for schools of fish. When a school is seen, the crew, with the exception of the ship-keepers, who are generally an officer and the cook, jump into the seine-boat and the dory and pull away toward the fish. When the seine-boat approaches the school, if the fish are not moving too rapidly, some of the men immediately begin to throw out the net, while the others pull the boat as rapidly as possible around the school, the object being to make a complete circuit of the fish with the apparatus. As soon as the first end of the net is thrown out, it is taken hold of by the two men in the dory, who are ready to run a small line to the seine-boat in case she fails to complete the circle with the net. When the seine is out all (the men in the dory, as well as others) immediately proceed to purse up the seine, that is, to gather in on the purse-line which reeves through blocks at the bottom of the net. This closes the lower part of the seine and forms it into a purse, or bag, which securely holds the fish from escape, providing they have not already taken fright and sunk out of sight before the operation of pursing is completed. If they still remain in the net the slack web of the seine is gathered in and the fish are "dried up," as it is termed. When this has been sufficiently accomplished, the captain and several of the men go on board of the vessel, which has been lying by in the immediate vicinity, and after filling away, shoot her to alongside of the seine-boat in such a manner that her headway is nearly done by the time she reaches the boat, to which lines are thrown; the edge of the seine is then got over the rail of the schooner. The fish are "dried up" as much as practicable so that they are brought into a compact mass, when they can be dipped out of the seine with a large dip-net and transferred to the well.

35. MISCELLANEOUS FISHING.

The miscellaneous fishing carried on by the *Grampus* in the course of her investigations embraces the adoption of various forms of apparatus and methods. Generally speaking, however, hand-lines are most commonly employed, these ranging from the size of a mackerel line, which is, perhaps, less than the thirty-second of an inch in diameter, up to a line for catching sharks and other large fish. Besides these there are the lines and harpoons adapted to the capture of sword-fish, porpoises and whales. Red snappers, groupers, and other bottom-feeding species, which frequent the Gulf of Mexico and adjacent waters, are taken with hand-lines somewhat similar to those employed for the capture of cod-fish. When red-snapper fishing, the vessel is generally hove to, as she would be for mackerel. In making an investigation of the southern fishing grounds she usually stands along on a given course for a distance of five or ten miles between trials. If the wind is sufficiently moderate a lead sinker, with baited hooks attached, is being constantly thrown out, as is the practice on board of vessels engaged in the red-snapper fishery, and in this way the presence of fish is determined.

Squid are caught on the common form of squid jig by bobbing it in the water at night, or in the day if squid are sufficiently abundant to bite at that time.

For the capture of sword-fish a pulpit is rigged on the jib-boom end, where a man stands to harpoon the fish as the vessel approaches them.

Porpoises are also harpooned from the jib-boom end or the head-rigging, but as they usually "play" under the bow, it is not always necessary to go far beyond the knight-heads to strike them. When one is struck the vessel immediately luffs to, the line is veered out until the vessel comes to the wind. As soon as her headway is stopped, the crew pull in on the line and bring the porpoise alongside; by the assistance of gaffs, or a strap and tackle, he is taken on board.

36. COLLECTING FISH EGGS.

To supply the hatcheries on the coast it has often been found necessary to obtain eggs from cod that were caught by the fishermen. The following description of this method is from a paper read by the writer before the Biological Society at Washington:

"It has frequently been found most advantageous to the work of the Commission for the *Grampus* to collect eggs from the cod which the fishermen catch, rather than to depend upon the procurement of eggs from the fish she would be able to take herself. When carrying on this work she generally has on board one or more expert spawn-takers. If the weather is favorable for fishing, the *Grampus* gets under way in the early morning, about the same time that the fishing vessels leave Gloucester Harbor, and proceeds with them to the fishing grounds, from 5 to 40 miles distant. There she cruises about among the boats to as-

certain where the most fish are being taken. This having been learned, her dories are sent on board the fishing schooners most liable to have large catches. In each boat are two seamen, who may be those who have been trained in taking eggs, and besides there may be in one or more of the dories one of our expert spawn-takers, sent out from the hatching station. An equipment of collecting pans, dippers, etc., is carried, the pans being peculiar in shape and specially designed for this outside work. Reaching the side of the fishing schooner, and watching the proper opportunity as the dory rises upon a wave, the men scramble over the vessel's rail and climb on board, taking with them their pans and other apparatus.

"Soon the schooner's dories arrive alongside, and their catch is thrown upon the vessel's deck. This is the opportunity for the Fish Commission men, who handle the fish as rapidly as practicable, selecting those that are ripe and immediately taking the eggs from them. This is continued until the last of the fish are thrown upon the deck and all the eggs are obtained which can be secured at the time. The men then quickly climb into their dory, and pull away for the *Grampus*, unless they see an opportunity of securing additional collections on board of some other vessel which has been longer delayed in hauling her gear. When the day's collection is ended and the dories have all returned to the *Grampus*, which in the mean time has been cruising back and forth, her officers watching every movement, she heads away for the harbor, where she anchors close to the hatchery on Ten Pound Island, and the eggs are quickly transferred to the hatching boxes, or shipped by rail to Wood's Holl."

The eggs of other species, including those of the mackerel, are sometimes taken in fine tow-nets. These are attached to the stern of the vessel, being towed from each side when she is going slowly through the water. The eggs thus obtained are immediately put into water, after being brought on board, and transferred to a hatching bucket described in another paragraph.

37. YOUNG FISH.

Young fish are taken chiefly in a large tow-net 6 feet in diameter, which is commonly towed from the end of the main boom when the boom is guyed well out over the vessel's quarter so that the net may be in water not disturbed by the schooner passing through it.

38. DREDGING.

The dredges are seldom used in depths exceeding 100 fathoms. They are bent to the end of the whale warp, and usually one or more 20-pound sounding leads are attached to the line from 5 to 10 fathoms above the dredge, so as to carry the latter to the bottom. The dredge is pulled in by hand.

39. SOUNDING.

For sounding on fishing grounds in moderate depths, an ordinary deep-sea sounding line is used, this being marked at every 5 or 10 fathoms. In the deeper waters off the edge of the fishing banks, where halibut occur, and where the depth ranges from 200 to 400 fathoms, soundings are obtained with the Tanner sounding machine. This apparatus is also used in shallow water where much accuracy is required. When sounding on a fishing ground, where it is not essential to have absolute accuracy, the vessel is simply brought head to the wind, without taking in any sail, and allowed to shoot until her headway is decreased, when the lead is thrown from the bow, the forward motion of the schooner bringing the line about plumb from the stern by the time the sinker reaches the bottom. Considerable skill and experience are required to insure success in sounding by this method, but in depths less than 100 fathoms it is practicable to obtain nearly accurate results, except in rough weather.

When trials for fish with hand-lines are to be made, the vessel is usually hove to before a sounding is taken.

When the Tanner sounding machine is used, the schooner is hove to on the starboard tack, in the same manner as when fishing for mackerel. Unless the wind is blowing strong, the drift is so small that the lead "strays" very little from a vertical position, and there is seldom any difficulty in obtaining accurate soundings.

J.—REMARKS CONCERNING THE GENERAL EQUIPMENT.

In addition to the special forms of apparatus, which have been described in detail, the general equipment of the *Grampus* includes much material intended for specific uses, besides that which is too miscellaneous to be specified. It is believed the following remarks are sufficiently explicit to convey the necessary information concerning it:

The outfit for navigation purposes includes, in addition to what has already been mentioned—

1 sextant.
2 marine clocks.
2 liquid compasses.
1 Azimuth compass.
1 Tell-tale compass.
1 Bliss patent taffrail log.
1 Aneroid barometer.
2 pairs of dividers.
2 parallel rulers (1 patent, 1 common).
1 pair binocular glasses.
1 fog bell.
1 watch bell.

The chart list includes three hundred and twenty-eight sheets of the Atlantic Coast and Harbors, covering the region extending from Labrador to the West Indies. There are several Coast Pilots covering the same territory.*

* The charts, with the exception of nine, have been supplied to the Commission by the U. S. Hydrographic Office and the U. S. Coast and Geodetic Survey, and the Survey has also furnished the Coast Pilots.

The log-books are obtained from time to time from the Bureau of Navigation of the Navy Department, and are the same as those carried on naval vessels.

The outfit of illuminating apparatus includes, among other things—

- 1 white signal or riding light (Tuft's patent lantern).
- 2 running lights (1 green and 1 red).
- 8 deck lanterns.
- 1 automatic flash torch.
- A series of Coston's signals.
- 10 swinging lamps for cabin, laboratory, etc.

Fifteen cork jackets and two life-buoys are carried, the latter being fastened, one to each davit, where they can be most readily thrown overboard in case of need; the former being distributed in the sleeping berths, where they may be conveniently to hand in case of an emergency. In this connection, mention may properly be made of the fact that the mattresses are all of the life-saving Ostermoor pattern, and the pillows are made of the same material as that used in the beds.

The bedding and mess furniture, both forward and aft, was furnished by the Commission, and the same attention has been given to insure the safety and comfort of the seamen as the officers or others who may be on the vessel. Indeed, it has been found necessary to have only one mess on board, and though the seamen, cook and cabin boy berth and eat forward, they are supplied in all respects with the same food as that furnished to the cabin table.

The cabin and forcastle are carpeted, and the cabin is heated by a stove which sits in the center. The outfit of mess furniture, while being serviceable, is plain and unostentatious. It is also necessarily less elaborate than it might be on a larger vessel, but is sufficient to insure the comfort of those on board.

The specialists who are detailed to accompany the vessel from time to time are supplied with bedding and other necessary mess furniture.

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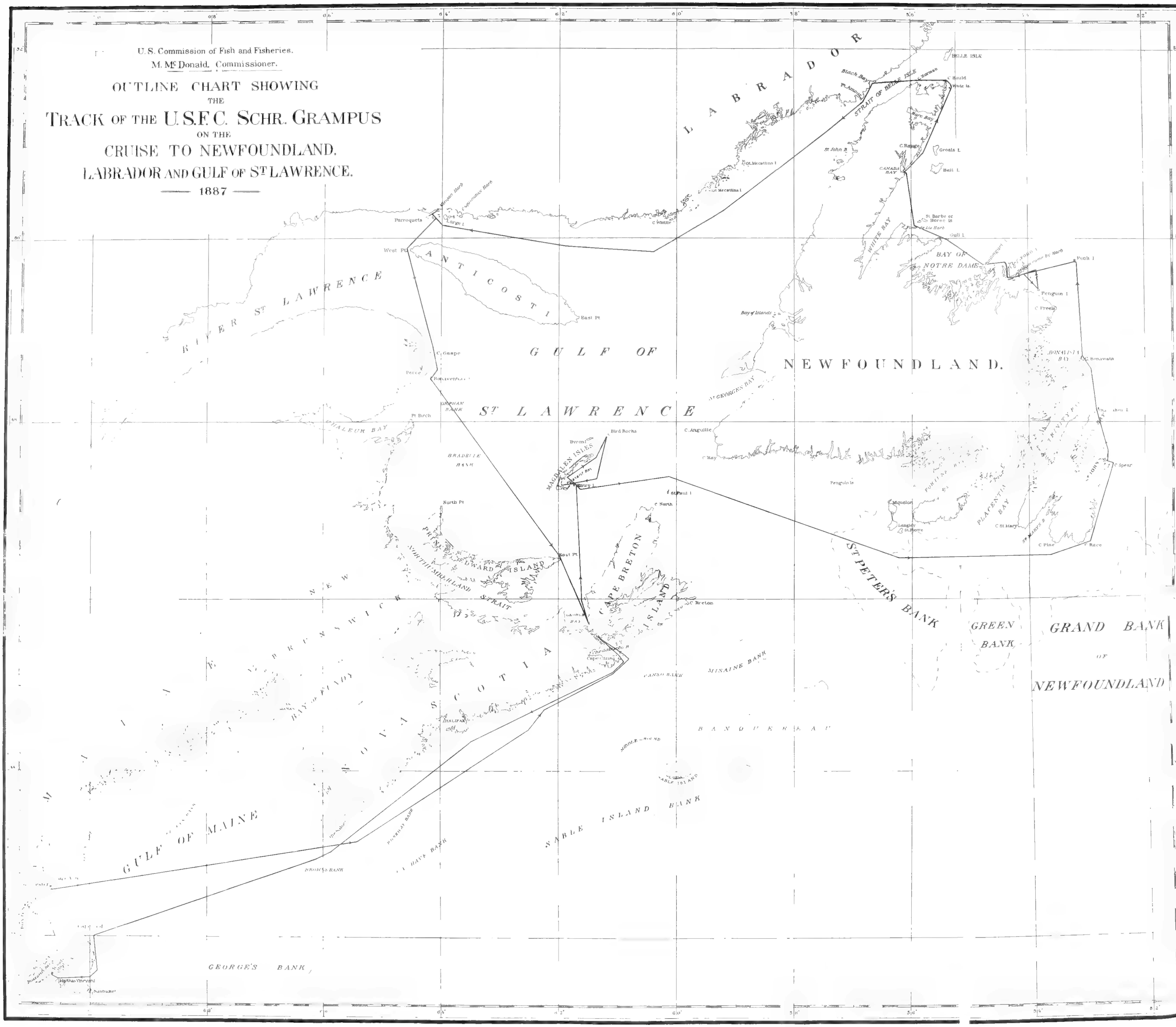
[NOTE.—The references are to page-figures in brackets.]


U.S. Commission of Fish and Fisheries.
M. McDonald, Commissioner.
OUTLINE CHART SHOWING
THE
TRACK OF THE U.S.F.C. SCHR. GRAMPUS
ON THE
CRUISE TO NEWFOUNDLAND.
LABRADOR AND GULF OF ST LAWRENCE.
1887
LABRADOR
NEWFOUNDLAND.
GULF OF
ST LAWRENCE
RIVER ST LAWRENCE
ANTICOSTI
STRAIT OF BELLE ISLE
BELLE ISLE
BAY OF NOTRE DAME
WHITE BAY
MAGDALEN ISLES
Bird Rocks
CAPE BRETON ISLAND
PRINCE EDWARD ISLAND
NORTHUMBERLAND STRAIT
NEW BRUNSWICK
NOVA SCOTIA
BAY OF FUNDY
GULF OF MAINE
MAINE
ST PETER'S BANK
GREEN BANK
GRAND BANK OF NEWFOUNDLAND
MISAINE BANK
CANSO BANK
BANQUEREAU
SABLE ISLAND
SABLE ISLAND BANK
GEORGE'S BANK
BROWN'S BANK
PLACENTIA BAY
BONAVISTA BAY
TRINITY BAY
CHALEUR BAY
ORPHAN BANK
BRADELLE BANK
Bay of Islands
ST GEORGES BAY
C. Anguille
C. Race
C. Pine
C. Spear
C. Bonavista
C. Freels
Penguin I.
Funk I.
Gull I.
St Barbe or Horse Is
C. Rouge
CANADA BAY
Groais I.
Bell I.
St John B.
C. Bauld
C. Whittle
Black Bay
Parroquets
West Pt
East Pt
C. Gaspe
Perce
Bonaventure
Pt Birch
North Pt
East Pt
St Paul I.
C. North
C. Breton
Miquelon
St Pierre
Halifax
Martha's Vineyard
Nantucket

6.—REPORT UPON THE OPERATIONS OF THE U. S. FISH COMMISSION SCHOONER GRAMPUS FROM MARCH 15, 1887, TO JUNE 30, 1888.

BY J. W. COLLINS AND D. E. COLLINS.

ANALYSIS.

I.—INTRODUCTION.

The present report upon the operations and investigations of the *Grampus* covers about sixteen months, from March 15, 1887, to June 30, 1888. The reason for this is found in the fact that, in the Annual Report for 1886, a review of her work was brought down to March 14, 1887, and it is therefore necessary to begin at that date and to extend the present report over the fiscal year ending June 30, 1888, in order that it will harmonize with the general plan of the Annual Report of the Commissioner for that period. Fortunately the cruises of the *Grampus* were so arranged that there is no difficulty in ending the report with the fiscal year.

It has been found necessary, in order to present the result of the work carried on upon the vessel in an intelligent way, to divide the report into three special sections: One of these deals with the investigations made in the spring and summer of 1887 on the mackerel grounds from Hatteras to Labrador, and also covers other researches which were made at the same time; the second section treats of the work of collecting fish and fish-eggs for the coast hatcheries; while the third takes up the investigations relating to the mackerel, menhaden, and other migratory species in the spring of 1888.

It will be evident to the most casual observer that it would be difficult, if not impossible, to discuss all these different investigations and operations in one continuous paper, excepting it take the form of a narrative, which would be far from desirable and would render it less valuable for reference, while the results obtained could not be so clearly shown.

The report of Capt. D. E. Collins upon the operations and investigations carried on by the *Grampus* while under his command in the spring of 1888 is a comprehensive review of the work performed. The fact that no mackerel were met with in the early part of the season is significant, and was a marked indication of the phenomenal scarcity of that species on all the western Atlantic fishing-grounds during the summer of 1888.

The illustrative material has been prepared under the direction of the writer. The map showing the track of the *Grampus* on her summer cruise in 1887 was drawn by Dr. C. E. Gorham, of the U. S. Fish Commission; the "track" shows only the general course of the vessel going and returning, since it was deemed undesirable to follow all the deviations caused by head winds, etc.

J. W. COLLINS.

II.—REPORT UPON THE INVESTIGATIONS MADE BY THE GRAMPUS FROM MARCH 15, 1887, TO SEPTEMBER 16, 1887.

BY J. W. COLLINS.

A. STUDY OF THE MIGRATIONS OF MACKEREL, ETC., SPRING OF 1887.

My last report on the work of the *Grampus* closed on March 14, 1887. At that time I was in Washington, D. C., engaged on special duty, to which I had been assigned by the Commissioner. During my absence from the vessel, First Officer D. E. Collins was appointed *pro tem.* to take command of her, and he remained in charge until after the completion of the spring's cruise to the southern mackerel grounds.

After the necessary repairs and preparations for a cruise were made, and certain apparatus which had been used during the winter was stored at Wood's Holl, and other necessary material taken on board instead, the *Grampus* sailed for the mackerel grounds north of Cape Hatteras on April 3. From that time until May 31 the vessel was actively engaged in making researches bearing upon the questions of the migration, abundance, and capture of mackerel, menhaden, and such other pelagic species as were met with. She had the good fortune to make the first capture of mackerel for the season. A few specimens were taken about 60 miles from the capes of the Chesapeake in gill-nets. A little later she was joined by Dr. Tarleton H. Bean, the ichthyologist of the U. S. Fish Commission, who continued on her during the cruise.

Every opportunity was improved to obtain knowledge of the presence and movements of mackerel and menhaden, either by making captures on board of the vessel or by communicating with the fishermen. Valuable service was rendered the fishermen on several occasions by informing them of the presence of schools of fish which had been discovered by the *Grampus*.

Collections of small crustacea which constitute the food of the mackerel were made. Young and immature fish were also obtained. Investigations were carried on to ascertain the presence, in the regions visited, of any of the *Gadidæ* or other valuable food species. Reference is made to the reports of the commanding officer, Dr. Bean, and Mr. Richard Rathbun (vol. VII, Bull. U. S. Fish Commission, pp. 217–267) for a full account of the results of the cruise.

B. INVESTIGATION CONCERNING THE MACKEREL, ETC., SUMMER OF 1887.

The *Grampus* arrived at Gloucester, Mass., on June 4, where I joined her six days later and resumed command. During the remainder of the month the vessel was refitted, repainted, and made ready for a summer cruise to the eastward. On July 2, we sailed from Gloucester on a trip to the Gulf of St. Lawrence, Newfoundland, and Labrador under the following orders from the Commissioner:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., May 10, 1887.

SIR: As soon as you have finished the explorations in regard to the location and route of travel of the southern school of mackerel and have properly refitted, you will proceed northward with a view to examining the condition of that fish in waters of a higher latitude. You will visit the Gulf of St. Lawrence and the coast of Newfoundland, and especially the eastern coast, where it will be seen that there are important observations to be made of the movements of the mackerel and other fish.

You are authorized to take with you Mr. Lucas and Mr. Palmer as naturalists, and you will give these gentlemen opportunity of making collections of the birds and eggs of the region in question; and also, with their help, make special examinations of any convenient localities for remains of the great auk. These may be sought for on the Funk and Penguin Islands, and wherever else you think the search will return satisfactory results.

I do not think it necessary to obtain any special authority from the Newfoundland government for carrying on the work here suggested; but should you stop at St. John's I would recommend you to see Rev. Mr. Harvey, and ascertain his views in the matter.

Yours truly,

SPENCER F. BAIRD,
Commissioner.

Capt. J. W. COLLINS,
Commanding Schooner Grampus.

1. OBJECTS OF THE CRUISE.

(*a*) *Mackerel.*—The objects of the cruise were various. It was deemed most important to determine the presence or absence of mackerel in certain regions where in former years they had been reported in abundance. These reports usually emanated from trading vessels which had visited regions not frequented by the mackerel fishermen. Accounts often reach the fishermen of the occurrence of immense numbers of mackerel on the coast of Labrador and about Newfoundland.

One of the localities where mackerel had been reported abundant the previous year (1886) was the region between the Bird Rocks (off the Magdalen Islands) and St. Paul's Island.

But, almost without exception, this information has reached the fishermen too late in the season for them to profit by it. Besides, in most cases there was a certain indefiniteness about the reports which left the fishermen in considerable uncertainty as to the correctness of information received. Consequently a cruise could not be made to those regions by fishing vessels unless at considerable financial risk.

It was therefore deemed important that definite information should be obtained as to the correctness of these rumors and reports sufficiently early in the season to enable the fishermen to profit by the knowledge, if mackerel were found within the limit of the cruise planned for the *Grampus.* In case fish were discovered in abundance in any of the waters visited, it was planned that the vessel should immediately sail for the nearest port where telegraphic communication could be had with the United States, when all the information obtained would be sent to the Commissioner, who would give it to the public.

(*b*) *Crustaceans.*—In connection with this search for mackerel it was deemed important that investigations should be made as to the occurrence of minute crustacea and other small forms of marine life upon which the mackerel feeds; and also that observations of the temperature of sea and air should be made.

(*c*) *Halibut.*—The obtaining of halibut in their spawning season, and the bringing of them alive to the United States in order that their eggs may be obtained for the purpose of artificial propagation, have for some years engaged the attention of the U. S. Fish Commission. It was therefore deemed desirable to make the attempt to catch halibut on the return trip somewhere about Labrador or Newfoundland, and bring them to Wood's Holl alive in the vessel's well.

(*d*) *Cod-fishery.*—The condition of the cod-fishery on the coast of Newfoundland and southern Labrador was a matter that deserved some attention, though perhaps of somewhat less consequence to Americans than the investigations relating to mackerel and halibut.

(*e*) *Great auk.*—Besides these researches, which relate specifically to the fisheries, it was (as the orders show) decided that collections should be made of the sea-birds which prey upon fish or are used as bait and

food by fishermen. Also, that their present status in their breeding places should be noted. In connection with this it was considered very important that a collection should be made of the remains of the great auk (*Alca impennis*, a species now extinct), which formerly frequented the islands off the coast of Newfoundland and at one time served an important function in supplying food to the fishermen.

2. DETAIL OF NATURALISTS.

Mr. Frederic A. Lucas, osteologist of the U. S. National Museum, and Mr. William Palmer, modeler and taxidermist, were detailed to accompany the *Grampus* on her trip. Mr. Palmer joined the vessel on June 30, and Mr. Lucas reported on board the following day.

3. NARRATIVE OF THE CRUISE.*

We sailed from Gloucester on the afternoon of July 2, and had a fair and uneventful passage to Canso. When we arrived off Cape Canso, about noon of July 6, the weather was very foggy. We succeeded, however, in passing the numerous outlying ledges without difficulty and ran into Chedabucto Bay. Soon after passing Canso Islands the weather cleared, and remained fine until we anchored at Port Hawksbury, in the Strait of Canso, at 4.45 p. m.

At 9.30 a. m. on July 7 we got under way, and, after leaving Canso and passing Port Hood, Cape Breton, ran for the Magdalen Islands, where we arrived and anchored under Grindstone Island, in Pleasant Bay, shortly after 1 a. m. July 8. We lay at that anchorage waiting for the wind to moderate until 5.35 p. m. on the same day, when we got under way and ran to the eastward, anchoring at 8.50 p. m. northeast of Old Harry Head. During the day collections of birds were obtained by the naturalists and some unsuccessful attempts were made to collect fish.

At 6.50 a. m. on July 9 we got under way at Old Harry Head and ran to the eastward for the Bird Rocks, off which we anchored at 12.50 p. m. The wind in the mean time had died away to a calm. Immediately after anchoring the two naturalists and I (with two seamen to row the dory) started for the smaller of the two Bird Rocks, where we spent the most of the afternoon in obtaining collections of sea birds, eggs, nestlings, etc., returning on board shortly after 5 o'clock.

At the time we returned to the vessel M. Turbid, keeper of the lighthouse on the larger Bird Rock, came off with his assistant and later we went on shore with him. He kindly gave every assistance in his power

* On June 27, while making a short run out of Gloucester Harbor, in order to inspect the new sails which had just been put on the vessel, having on board Mr. E. L. Rowe, maker of the sails, the mate, Mr. D. E. Collins, was so unfortunate as to get his right hand badly jammed with the anchor. He was taken on shore and put under medical treatment, but his condition was such that he was not able to join the vessel and remained on shore during the cruise. The second mate, Mr. Charles H. Griffin, acted as mate during the trip.

in making collections of such birds as were not obtainable on the other rock and also presented us with a full series of eggs of birds that breed at the rocks, which he had secured a short time before our arrival.

Trials were made during the afternoon and evening for mackerel, but without success.

There was little or no wind until next morning and we lay at our anchorage off the Bird Rocks until 6.30 a. m. on the 10th, when we got under way with a moderate southeast wind. It was proposed to make some trials for mackerel off the Magdalens and toward St. Paul's Island and then to go as direct as possible to St. John's, Newfoundland. The wind increased rapidly, however, and the sky became overcast and threatening. The course was therefore changed to west by north for Entry Island. At 11 a. m., when about 15 miles east by south from Entry Island, we hove to and threw toll-bait for mackerel and put out hand-lines for cod and halibut. Eleven cod, two rusty flounders, and one small halibut were caught. After making this trial we ran into Pleasant Bay, where we anchored at 4.30 p. m. off Amherst Harbor.

Shortly after anchoring, we were visited by the American consular agent, Mr. Leslie, and by two young American naturalists who were making collections of the fauna of the islands.

While at this place a few birds and other specimens of local fauna were collected by our party. On account of stormy weather we lay at our anchorage in Pleasant Bay until 8.30 a. m., on the 13th, when we got under way with a moderate breeze from the east-southeast; weather overcast and stormy looking. The wind, however, did not continue from that direction, and when we were about 4 miles south-southeast from Entry Island it died away nearly calm. At 2 p. m. we hove-to and tried to "raise" mackerel with toll-bait, and at the same time put out hand-lines for bottom fish. Five small cod and one halibut were caught on the lines, but, nothwithstanding the fact that we threw toll-bait for upwards of an hour we were unsuccessful in finding any mackerel. A light wind sprung up at 5 p. m. from about northwest by west, but finally became steady from west. We steered a course to pass north of St. Paul's Island.

In the early part of the morning of the 14th there was a moderate breeze from south by east to south-southwest, with an overcast sky and rapidly falling barometer. About day-break the weather became very threatening and squally, with heavy rain showers, and continued so until near noon, when it cleared somewhat. Sighted the west end of St. Paul's Island bearing about west-southwest 8 miles distant. The wind veered suddenly to northwest about 7 a. m. and continued strong and fresh with a rough cross sea on starboard beam; the vessel making a course to clear St. Pierre. At 7.18 on the morning of the 15th St. Pierre bore northeast by north, about 15 miles, and at 7.45 p. m. Cape St. Mary was just in sight bearing northeast by north. The weather was pleasant and generally clear during the 15th, with a light

FUNK ISLAND BEARING N.N.E., FIVE MILES DISTANT. (See page [9].)

From a painting of A. Z. Shindler after sketch by J. W. Collins.

breeze from west around to south. Sea-birds were seen in abundance, and several humpback whales were noticed.*

At 4.23 p. m. set the vessel's signal numbers for the Cape Race light-house station, which we were then passing, but probably on account of the exchange of signals between that place and a steam-ship, ours were not understood, and when asked to repeat them we had gone too far to do so.

Passing Cape Race, we continued on our course for St. John's, encountering a dense fog at 7.40 p. m., when Renewse Head bore north-northwest $3\frac{1}{2}$ miles distant. Towards midnight the weather cleared and we sighted Ferryland Head Light.

The wind continued moderate during the morning of the 17th, with a fog in the early part and clearing weather later. At 2 p. m. passed Cape Spear and at 3.18 anchored in St. John's Harbor. I called on the American consul shortly after anchoring.

In the afternoon, Capt. D. Baxter, who had been engaged as pilot for the Newfoundland coast, reported on board and informed me that he would not be able to start on the cruise until the 20th, since he needed two or three days to arrange his private affairs.

We laid at St. John's until the morning of the 21st, having been detained chiefly by bad weather. During our stay here the vessel was visited every day by the citizens of St. John's, who inspected her and expressed much admiration for the schooner, as well as decided approbation of the objects of the cruise. Collections of the local fauna were made, consisting of plants, birds, fish, etc.

At 10 a. m. on the 21st we got under way and beat out of the harbor, the wind at that time being from the eastward and blowing directly in. After getting clear of the harbor heads we ran up the coast with a stiff breeze from southwest by south. At 8.45 p. m. passed Cape Bonavista and steered for the Funk Islands. At 12.20 p. m. on the next day we ran close to the east end of Funk Island and sent Messrs. Lucas and Palmer on shore in a dory, provided with a full equipment of tent, stores, water, etc., for camping, and tools for digging. The vessel was then headed for a rocky shoal spot $1\frac{1}{2}$ miles east-southeast from the island, where we anchored at 12.53 p. m. Shortly after anchoring I went on shore to assist the naturalists, being accompanied by Pilot Baxter and two seamen.

The group called Funk Islands (see plates II and III) consists of three islets, which are about 30 to 35 miles from Cape Freels. Two of these islets are simply low ledges a few feet above sea-level and washed by the waves when there is a heavy sea. These lie a short distance nearly north from the western end of the larger island of the group. The latter is about three-quarters of a mile in length and perhaps one-third of a mile wide. Its height is put down as 46 feet, but we thought it was higher. It is on the western end of the larger island, where alone

*See special notes for details concerning appearance of birds and whales, pages [35] [36].

there is any soil over the granite rocks and ledges (that elsewhere stand out in bleak nakedness), that the remains of the great auk were found in profusion, a few inches below the surface.

The collections made at this place embraced a large number of bones of the great auk, besides many birds, eggs, fledglings, plants, etc., and were extensive enough to fully satisfy the naturalists, since all or nearly all of the different things that could be obtained on the island were secured.

While the vessel was at anchor in the offing, trials were made with hand-lines for cod and other bottom fish, but with negative results only. We lay at anchor off the "Funks" until the afternoon of the day succeeding our arrival there.

After getting all the collections and collecting party on board, we got under way at 3.30 p. m., on the 23d, and passing Funk Islands our course was laid for the Penguin Islands, which lie northwesterly from Cape Freels. But, since the wind changed and increased considerably in force after we started, it was decided a little later to run for Seldom-come-by Harbor, which it was believed we could reach before dark. The wind fell light, however, and drew dead ahead, so that, with an unfavorable current, we could not reach the harbor before nightfall. Therefore, at 10.15 p. m. we anchored 2½ miles southeast from Cann Island Light.

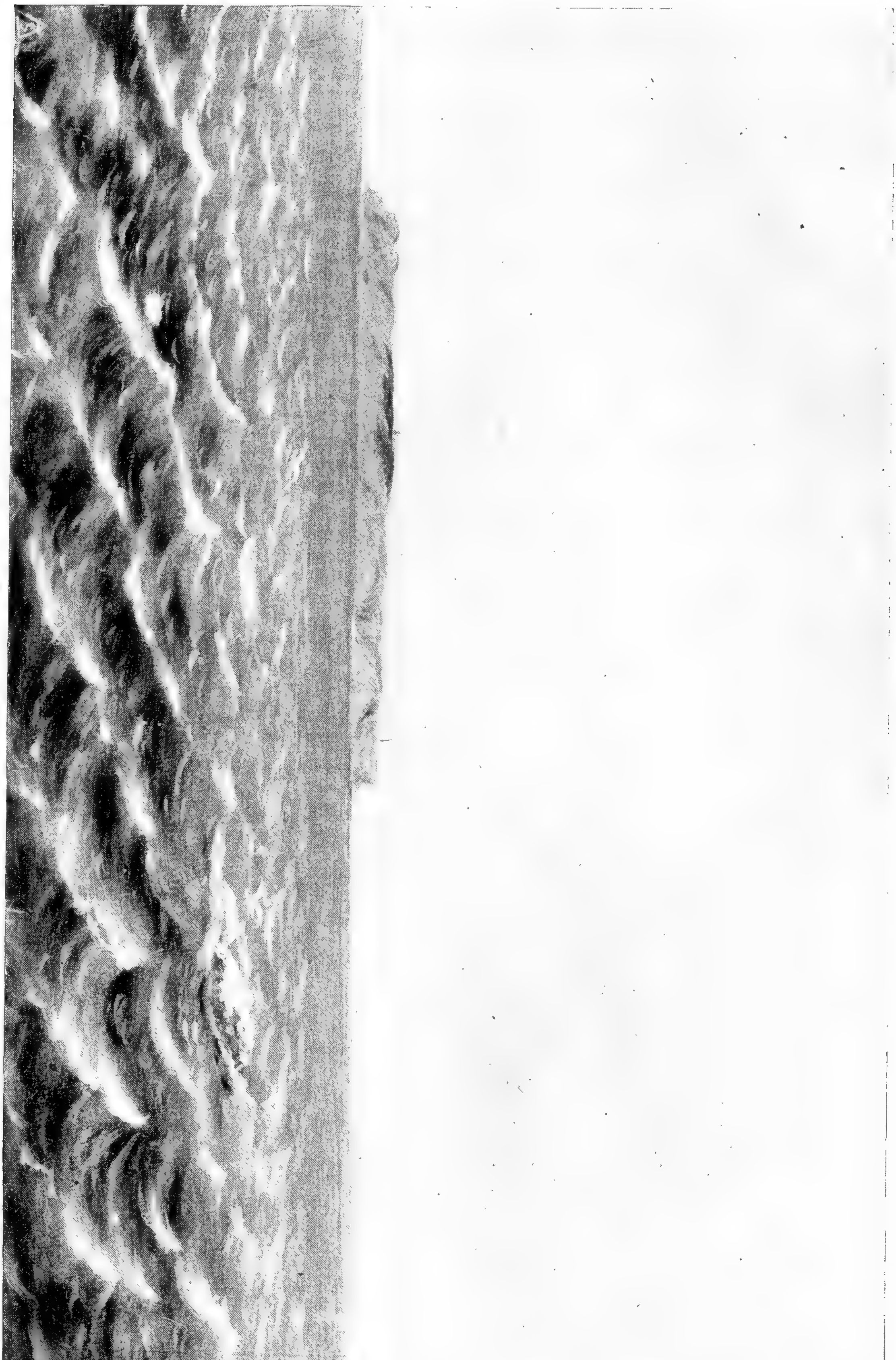
We got under way at 8.25 on the morning of the 24th and ran for the Penguin Islands, through the inner passage, by Copper and Gull Islands. We anchored off the north Penguin Island at 10.50 a. m., and sent a collecting party on shore. The collections made here consisted of small land birds, sand-pipers, petrels, field mice, etc. Excavations were made with the hope of finding remains of the great auk, but nothing was obtained to indicate that it had ever inhabited this island.*

The party soon returned on board and at 2 p. m. we got under way and, passing between Coleman's and Small Islands, beat up to Little Seldom-come-by Harbor, anchoring there at 8 p. m.

The next morning Mr. Lucas and I started on an expedition to a small pond about 1½ miles from the harbor, where we were informed it was possible to obtain specimens of trout, gulls, ducks, etc. Seaman Osier accompanied us and assisted in carrying the outfit. After scrambling over rough rocky hills and struggling through a mass of burned and fallen timber we found the pond. Trout were abundant, but, contrary to our expectations, no birds could be obtained; the gulls seen were exceedingly shy and did not venture within gun shot. A limited collection of small land birds was made.

The weather on the 26th was generally clear and fairly pleasant, with a west-northwest wind, which changed to north, veered to the southeast, and finally became steady from the eastward. We got under way

* The name of these islands suggested the possibility that they had formerly been frequented by the great auk, known here as the "pin-win," a corruption of Penguin.



FUNK ISLAND BEARING W.N.W., ONE AND A HALF MILES DISTANT. (See page [9].)
From painting of A. Z. Shindler after sketch by J. W. Collins.

at 8.25 a. m. and started for Toulinguet, going through Stag Harbor Run. We took in tow the boat of the keeper of the light-house at Cann Island, who was going to Fogo. The passage through Stag Harbor Run was made without difficulty, after which we beat up between Fogo and Change Islands until we could lay our course to windward of the latter. Anchored at Toulinguet at 3.50 p. m. The object of visiting this place, which is the largest town on the northeast coast of Newfoundland, was to make inquiries concerning the appearance of mackerel at White Bay and elsewhere along the northeastern coast and to get information which it was important to have concerning other fishery matters in this section.

In the evening we visited the mail-steamer *Plover*, which had just arrived from Labrador, and made inquiries of her captain concerning the abundance of cod, mackerel, etc., at the points he had recently visited. I learned that all the fisheries of Labrador and northeastern Newfoundland had been so utterly unremunerative up to that date that it was feared the fishermen might meet with absolute failure for the entire season.

During our stay at this place many visitors came on board. Information was telegraphed to the Acting Commissioner of our arrival and intended departure the next day. It was, however, impracticable to get away on the 27th as planned, since a calm prevailed during the entire day. Attempts were made to collect specimens of local fauna, but with little or no success.

The wind on the following morning was a gentle southwest to south by west breeze, increasing to a stiff breeze and then decreasing. We filled away and ran out of Toulinguet Harbor at 4.05 in the morning, steering a course to clear Cape St. John's, which point we passed at 11.45 a. m., going between the cape and Gull Island. We then steered for Partridge Point. The wind was light in the afternoon, and at 4 o'clock, when off Bay Verte, we hove-to and threw toll-bait for mackerel; also put out cod hand-lines for bottom fish, but were unsuccessful. While making this trial for fish the trading schooner *Phœnix*, of Toulinguet, was seen standing off-shore towards us. Messrs. Baxter and Lucas boarded her, and learned that no mackerel had been seen in White Bay during the summer.

The news of the absence of mackerel at White Bay caused a change in my plans, and instead of going to Fleur de Lis Harbor, it was determined to run for Canada Bay, where we had been informed mackerel are sometimes seen, and where also it was thought information concerning the cod-fishery might be obtained.

Failing to catch mackerel or cod, we got under way again at 5 p. m., but in less than two hours afterwards the wind fell away to a calm, and light baffling winds and calms continued during the night. All of the morning and early afternoon of the 29th there were light, unsteady cat's-paws and calms, with fog. There were occasional partially clear

intervals, in which the land could be seen, but it was not until 3.15 p. m. that we were able to reach Grevigreux Harbor, where we anchored, the wind dying away to a calm and a dense fog shutting in soon after our arrival.

On account of light winds and heavy fog it was not practicable to leave Grevigreux until August 3rd. During this stay numerous expeditions were made inland, as well as to points in the bay, where attempts were made to capture porpoises and to collect other objects which were considered of interest and value. On the morning of the 30th of July a party, consisting of Pilot Baxter, the two naturalists and one seaman, visited Torrent Cascade, or "Hell's Mouth," as it is locally called, on the opposite side of Canada Bay. The expedition returned at 5.20 in the afternoon, having secured specimens of fish, etc. Several attempts were made to capture porpoises, but they were so shy it was impossible to approach them within gunshot.

On August 2d Messrs. Baxter, Palmer, and one seaman went to Otter Cove and Cloud Hills to make collections. They returned in the evening, having secured two ptarmigan and some smaller land birds, among which were two species not previously obtained. The ptarmigan were especially valuable, since they were the *Lagopus welchii*, and were in their summer plumage, in which this species had not previously been taken by naturalists.

The morning of the 3d was fine and clear, with a light and somewhat unsteady breeze from the southward; the weather continued fine throughout the day, later with the wind southwest by south to southwest, increasing from a light to a moderate breeze. At 8.30 a. m. we left Grevigreux Harbor and ran out of Canada Bay. After we were well past Englee Island we ran up the coast toward the Strait of Belle Isle. At sunset the White Islands were in plain sight, and at 9.24 p. m. we passed them; at 10.15 p. m. we passed Cape Bauld and hauled-to for Cape Norman in the Strait.

At 1.15 a. m., on the 4th, when Cape Norman bore west one-half south, about 2½ miles distant, we hove-to on the port tack with head sails to windward. The object of stopping at this place was to make inquiries of the boat fishermen concerning the occurrence in the vicinity of mackerel and other species of food-fish. Soon after daylight we filled away and stood toward Cape Norman, but hove-to for a few minutes to obtain a supply of ice from fragments of bergs which were drifting near by.

Under the lee of Cape Norman we saw a large fleet of fishing boats at anchor. After we arrived in their vicinity, Pilot Baxter was sent in a dory to make inquiries concerning the fisheries. One of the boats came alongside, however, and her crew of two men reported that they belonged to the schooner *Edward Rich*, of Catalina, Newfoundland. From their statements we learned that the schooner had been at Cape Norman, or near there, since June 25, where she had been engaged in

fishing for cod and herring. These men stayed on board ten or fifteen minutes, and as soon as they departed we filled away to beat through the Strait.

At 8 a. m. the yacht *Sapper*, of Bay of Islands, Newfoundland, passed across our stern, running "winged out" to the eastward. She saluted us by setting the Episcopal Church pennant, the Episcopal bishop of Newfoundland being then on board of her making his annual visit to the churches in his diocese. The salute was returned.

About noon the wind increased to a fresh and strong breeze from west by south to west-southwest, and there were indications of more wind. The tide also began to set to the eastward, making it difficult to beat through the strait against the sharp choppy sea that was running. Therefore we went into Black Bay for shelter, anchoring at the head of the bay at 1.50 p. m. The schooner *Terror*, of Shelbourne, Nova Scotia, lay at anchor there, being engaged in trading on the coast.

Later the wind increased to a strong westerly gale, with heavy squalls and thick weather. The weather remained unfavorable, and detained us in Black Bay until August 8th. On the 5th I went on board of the *Terror*. Capt. J. W. Pitts, who was in command of her, and who had been cruising along the coast from Mingan to Fox Bay, on the Labrador coast, gave me considerable information concerning the abundance or absence of fish in the localities which he had visited.

On the morning of the 5th a party of four went on shore on a collecting expedition. Little success was met with in shooting, only two sand-pipers being bagged in a tramp of several miles. A large collection of plants, among which were numerous species of mosses, was obtained.

Mr. Lucas was very successful in catching trout in a brook which flows into the river that empties into Black Bay. Near the mouth of the brook, which is about 2 miles from the mouth of the river, the fish were small, but farther up the stream, near the rapid, fine trout were abundant. He caught a total of 36 pounds, and two of the largest had a combined weight of $4\frac{3}{4}$ pounds.

In the early morning of the 8th there was a light northeast wind, which increased to a moderate gale later on, with heavy squalls off the land. At 4.40 a. m. we got under way, under lower sails, and ran out of the Strait. Soon after starting we double-reefed the mainsail and furled it, and ran under whole foresail, jib, and forestay-sail for about two hours, when we set reefed mainsail. At 6.45 a. m. passed Amour Point. Half an hour later the wind came off the land in a squall, blowing heavy; lowered and furled the foresail and jib. The weather became somewhat settled later, and at 9 a. m. we set foresail and jib, and hoisted the flying jib in the afternoon. Little Mecattina Island bore north at 5.30 p. m., when the wind moderated very suddenly from a fresh to quite a light breeze from east by north. Shook reef out of mainsail and set the light sails. Later the wind backed around to the northwest, blowing a gentle breeze.

On the 9th the weather was fine, with some cloudiness and indications of rain, with a gentle to moderate breeze varying from northwest to south-southwest, and brief periods of calms. Between 5.30 and 6.15 a. m. tried for cod with hand-lines baited with fresh capelin; no fish were taken.

At 6.30 a. m. put out ship's dredge in 51 fathoms on the western edge of Natasquan Bank. Little of interest or value was taken in the dredge. The small surface towing net was used several times during the day, but nothing was taken in it.

During the 10th the wind varied from west by north to northwest by west, blowing a moderate breeze in the early part, baffling and unsteady in force, with calms, for the rest of the day. The weather was pleasant but hazy, with a strong mirage in the afternoon which distorted the appearance of the land very much.

Phalaropes were abundant and two were shot in the afternoon. The surface net was towed on several occasions, but nothing was taken in it.

At 3.30 p. m. spoke with a fishing-boat, which was running in for harbor, off Esquimaux Island. We came to anchor shortly before 8 p. m. in 27 fathoms, off the western end of Large Island of the Mingan group, which bore north one-half east, about 4 miles distant. I had wished to reach the Parroquets, of the Mingan group, before anchoring, but as the wind died away to nearly a calm and the tide was making to the eastward, it was decided to anchor and wait for an increase of wind or a change of tide. After anchoring we put out hand-lines baited with capelin, and caught one small codfish.

At 4.15 a. m. on the 11th we got under way with a stiff east-southeast breeze, the weather at the time having a threatening appearance. We ran for Mingan Island, which we left on the port, and stood in for a fishing station on the mainland opposite the island, where we anchored at 5.48 a. m., in twenty fathoms of water, about two-thirds of a mile from shore. The object in anchoring there was to make inquiries concerning the occurrence of halibut in the vicinity of Mingan Island, and also to obtain some information about the gray seal (*Halichœrus grypus*) that frequents this region and which we wished to get specimens of.

Immediately after we anchored two men came off from the shore in a boat and boarded us. One of these gave us much information concerning the seals, halibut, and topography of the region. The latter information was very important, since I had no charts on board of that locality on a scale sufficiently large to be useful.

It was determined to make an effort to obtain some seals that day, since the weather was not suitable for fishing. Therefore, at 7.15 a. m., we got under way and ran over for Mingan Island, where we anchored half an hour later in 25 fathoms, the center of the island bearing southeast about one-half mile distant. Immediately after anchoring, I went on shore, accompanied by Messrs. Lucas and Palmer, with two seamen to look after the boat. Rifles and guns were carried so

that we might be prepared for either small or large game. Seals were seen hauled out on the lee side of the island, but all attempts to secure them failed, owing to their extreme timidity and alertness. Better success was met with in securing specimens of birds.

The threatening condition of the weather made it somewhat risky to remain long on the island, and I determined to beat down to Mingan Harbor before the flood tide made. It was, therefore, arranged that our party, which separated on landing, should assemble at the boat about two hours later to go on board.

A little after 10 a. m., however, the Canadian cruiser *La Canadienne*, which came from the westward, anchored near the *Grampus*, lowered a boat and went on board our vessel. As soon as our party got together we returned on board, where I found Commander William Wakeham, inspector of fisheries for the province of Quebec, who was in command of the cruiser. In conversation with the mate he had learned that we had no suitable charts of Mingan, and he had very courteously sent his boat back to the cruiser for some sheet charts of the region, which he presented to me. He also generously offered to send on board a pilot, or to render any other assistance which was needed. The charts he had furnished were so detailed that I felt safe in going by them without the assistance of a pilot. The *La Canadienne* got under way a little before we did, but steamed along slowly, apparently waiting for us to start. We filled away at 11.30 a. m., under all lower sails and maingaff-topsail, and less than an hour later tacked off the western entrance of Mingan Harbor, and began beating against the flood tide which was running fully 3 knots in the narrows. Shortly after 1 p. m. we anchored in 9 fathoms off the Hudson Bay Company's buildings. About an hour later a collecting party was sent on shore.

On the 12th the weather was thick, with fog and rain, and a moderate breeze from east-southeast to south-southeast. Messrs. Lucas and Palmer and two seamen were on shore collecting most of the day, but aside from botanical specimens little of value was obtained.

In the afternoon Commander Wakeham introduced Mr. Dugay, the Canadian fishery agent at Mingan Harbor, and instructed him to assist us in any way in his power, and particularly to aid in any effort we might make to secure specimens of trout or salmon for our collection.* This was especially important to us, since the river fisheries in this region are leased by the Government to private parties, who will allow no one to fish in them without permission.

Two Indians, who were accustomed to hunting seals, were engaged to go with us as soon as the weather permitted us to visit the western islands of the group, where the haunts of the gray seal are situated.

On the 13th the weather cleared up, and the wind, which was from

* It may be explained that the obtainment of specimens of trout from the regions visited by us was considered important, since they were needed for study by the Commission.

the eastward in the early part of the day, changed to north and northwest later. The *La Canadienne* got under way at 4.30 a. m., and steamed out of the harbor to continue her cruise. Although the weather was clear and fine, and the wind reasonably moderate throughout the day, there was a heavy surf rolling in on the shores. It was the opinion of all familiar with the habits of seals that none would haul out until the sea got smooth, and for that reason it was not advisable for us to leave the harbor to seek them.

Mr. Lucas went up the river after trout, but, although fish were abundant, none could be taken because the recent rains had caused a considerable rise in the river and the water was too muddy for the fish to see the bait or a fly. Messrs. Palmer and Baxter and one seaman went across to the Inner Birch Island on a collecting trip. They returned about 8 p. m., having met with only indifferent success. I made a collecting trip to Harbor Island, but got only two pigeon hawks.

We lay in the harbor all day on the 14th, and nothing of especial moment occurred outside of an unsuccessful attempt to capture a pike whale (*Balænoptera*) that came near the vessel.

On the 15th the conditions were favorable for seal hunting. As soon as practicable the Indians who were to accompany us were brought on board. They took with them their bark canoe, guns, and seal-skin jackets for disguise. At 8.25 a. m. we got under way with a northwesterly wind and beat down for the Parroquet Islands. When a little to the westward of Mingan Island we hove-to for a short time, the wind being fresh with a choppy sea getting up. It was finally decided to anchor to the leeward of Mingan Island, which we did at 11.45 a. m., in 30 fathoms of water. About a half-mile to the southward of us a herd of seals was seen hauled out on a long, rocky point. An unsuccessful attempt was made to shoot some of the seals during the afternoon.

While the party was on shore hunting seals, toll-bait was thrown for mackerel, but without successful result. An attempt was made to catch squid during the night watches, as on previous nights, but none were taken.

We lay at Mingan Island during the night, and before daylight on the morning of the 16th a party went on shore hunting seals, but failed to accomplish anything. Another attempt was made to "raise" mackerel in the early morning with the same result as on the previous day.

At 8.40 a. m. we got under way and beat over to the Parroquets. When to the westward of Mingan Island Messrs. Palmer and Baxter, with one seaman, left the vessel in a dōry and landed on the island to hunt for birds. Later we anchored in 34 fathoms northwest from Eastern Dry Reef, about one-fourth of a mile distant. Seals were seen in abundance swimming around the reef, but owing to the tide being flood, and therefore deemed unfavorable by the Indians, an attempt to shoot seals was deferred until the middle of the afternoon. The animals, however, were so excessively shy that all efforts to secure one failed.

The weather was threatening the latter part of the afternoon, with a low barometer. We therefore got under way at 6.40 p. m. to run for Mingan Harbor, and less than a half hour later picked up the dory with Palmer and Baxter. There was a brisk breeze when we started, but when we were about a mile distant from the entrance to Mingan Harbor the wind suddenly fell away to a calm, so that we were compelled to anchor and lay there for the night.

On the following day the weather was threatening and rainy. We got under way at 6 a. m., and ran into Mingan Harbor, where we were detained by unfavorable weather until the 20th.

Collecting parties went out every day, and repeated attempts were also made to obtain enough bait to enable us to set our trawl-lines for halibut. There were, however, practically no squid at Mingan, and capelin, which had been abundant before our arrival, were exceedingly scarce and difficult to catch. The surf on the beach, resulting from fresh winds, made it specially difficult to catch capelin, which otherwise might have been taken in small quantities. By hard work we succeeded in getting enough to bait 1,000 halibut hooks on the afternoon of the 18th, on which occasion the gear was put in order to set as soon as the weather permitted us to leave the harbor.

We got under way at 4.25 a. m., on the 20th, with a gentle breeze from the west-northwest, and started for the halibut grounds outside of the group of islands. The wind increased very rapidly, however, and by the time we reached the fishing-grounds it blew fresh, with a choppy and rough sea; the swift current caused the water to break and tumble in heavy rips that were dangerous for small boats to go into. When we stood out of the passage-way between Birch and Mingan Islands, finding it too rough to attempt trawl-line fishing, we hove-to for awhile on the port tack waiting to see if the wind and sea would moderate. There were no indications, however, that there would be any decrease in the wind, and since our bait was already in a poor condition and it would be unfit for use on the following day, I concluded to abandon the idea of setting the trawl-lines for halibut, more especially as there was small probability of getting another supply of bait. It was therefore determined to run to Percé, where it had been decided to make a brief stop. Accordingly we stood across for Anticosti Island. We had rather a hard beat against a strong wind and choppy sea, but at 3.18 p. m. we passed the western point of Anticosti and steered for Cape Rosier.

A little before 7 a. m. on the 21st we hove-to and tried for mackerel in a depth of 50 fathoms, Cape Gaspé bearing north and Bonaventura Island west-northwest. Cod hand-lines baited with capelin were put out; no fish were caught. After lying-to for an hour we kept off for Bonaventura Island. We arrived off the southeast end of the island at 9.15 a. m., and lay to with head-sails to windward, while Messrs. Palmer and Lucas, with two seamen, left the vessel in a dory to investigate

the bird rookeries on the cliffs at Bonaventura. The party returned on board a little before noon, and soon after we filled away and stood into Percé Harbor, where we anchored at 1 p. m., to the eastward of Percé Rock.

We lay at Percé until the next noon. In the meantime collections were made of birds, etc., and considerable information was obtained concerning the local fisheries and the occurrence of mackerel.

Leaving Percé Harbor about noon on the 22d, we steered straight for East Point, Prince Edward Island, where we arrived early in the afternoon of the following day. Off East Point we saw a fleet of upwards of thirty sail of American mackerel schooners. The first of these we met was the schooner *Matthew M. Murray*, of Gloucester, Mass. She was about 7 or 8 miles northwesterly from the point. As we approached she steered to intercept us, seeing which we hove-to with jibs to windward. We spoke with the captain, who was anxious to learn the news concerning mackerel along the "north shore" and in the other regions we had visited. At the time we spoke to the *Murray* another schooner was noticed standing down the island, inshore of us, with all light sails set, and evidently trying to intercept us. We therefore kept off to meet the schooner, and as soon as we did so she began shortening sail and soon after hove-to. As we approached a dory was seen pulling to meet us. We therefore hove-to, at 12.44 p. m., for the boat to come alongside. She contained Capt. Loring Nauss and two of the crew of the schooner *Moro Castle*, of Gloucester. He had recognized the *Grampus*, and was very anxious to learn what information we had obtained about mackerel on our cruise. Captain Nauss remained on board nearly half an hour, and from him I learned much concerning the mackerel fishery by American vessels in the Gulf and of the catch by boats belonging at Prince Edward Island. As soon as he left we kept off to run past East Point. Several of the mackerel fleet intercepted and spoke with us to learn what news we had to tell them. Among these were the following schooners: *A. M. Burnham*, *Governor Butler*, *Nellie E. Davis*, *Maud M. Story*, *Howard Holbrook*, of Gloucester, and *Lucy Jenkins*, of Wellfleet. All of these were furnished with such information as we had to impart.

We passed Henry Island, off Port Hood, at 6 p. m., after which the wind gradually grew light until it was almost a calm. Shortly after 9 p. m. we anchored off Cape Jack Light at the northern entrance of the Strait of Canso, the tide having turned to the northward and there not being wind enough to make any way against it.

We lay at anchor until 4.25 on the following morning (24th), when we got under way with a light breeze and beat through the Strait, anchoring at Port Hawksbury (at 7 a. m.) where we stopped to get our mail, fill water, and purchase some necessary supplies.

Here I saw an account in a Boston newspaper of the death of the late U. S. Commissioner of Fish and Fisheries, Prof. Spencer F. Baird. The flag was set at half-mast.

During the forenoon I met Commander Wakeham, of the *La Canadienne*, and Lieutenant Gordon, R. N., commanding the Canadian steam cruiser *Acadia*, and a little later both gentlemen came on board to visit the *Grampus*.

At 4 p. m. the yacht *Ruth*, of New York, homeward bound from a cruise in the Gulf of St. Lawrence, anchored near us. Soon after we got under way and beat to the southward through the Strait, the tide at this time being favorable. Toward sunset the wind decreased and the sky had a threatening appearance, which indicated a storm. Therefore, as the wind was ahead, we anchored at 7.15 p. m. under Eddy Point near the light-house, and laid there for the night. The schooner *Pioneer*, of Gloucester, which was also homeward bound, anchored near us and two of her crew came on board.

On the morning of the 25th the wind was fresh from east-southeast with thick rain and indications of a heavy gale.* At 5.15 a. m. got under way and ran to Port Hawksbury, where we anchored at 7 a. m. In the harbor lay several American mackerel seiners which had come there for shelter. During the forenoon Captain Whitman, of the schooner *Gracie C. Young*, of Rockland, Me., came on board to learn the news about mackerel in northern waters.

The weather remained unfavorable until the 27th, when we got under way at 6.45 a. m. and ran across to Canso Harbor, where we anchored at 9.30 a. m. In the harbor was a fleet of forty or fifty fishing vessels, among them many American mackerel schooners bound home. The sea resulting from the recent gale was excessively heavy along the coast and broke with tremendous force on the ledges outside of Canso Harbor. This kept the fleet from leaving, though the wind was fresh from west-northwest. In the afternoon the wind veered to the northwest, still blowing a fresh breeze. We got under way at 12.45 p. m., and ran out of the harbor, passing Roaring Bull Ledge at 1.40 p. m. Outside, the sea was high and steep, causing the vessel to pitch somewhat heavily as she headed directly into it. Several of the fishing schooners left about the same time, and the yacht *Ruth* started a little later. Before we reached the vicinity of White Head we ran out of the northwest wind and into a light unsteady breeze from southwest to west-southwest.

The passage home was uneventful. We arrived at Wood's Holl at 7.14 p. m. on September 1, and anchored off the Fish Commission wharf for the night. On the following day the vessel was moored alongside the wharf and the collections were taken on shore and packed for shipment. I telegraphed Mate D. E. Collins, who was at Gloucester, to join the vessel, which he did that evening.

On September 3 I went to Gloucester, where I remained until the 7th.

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* During the day a heavy hurricane occurred off the southern coast of Nova Scotia, but, while it blew strong in the Strait of Canso, the wind did not reach hurricane velocity.

While there I met many owners of fishing vessels, who were desirous of learning the facts concerning the fishery investigations made by the *Grampus*, and were also anxious to obtain my opinion as to whether mackerel were most likely to be abundant in the Gulf of St. Lawrence or off the New England coast.*

On September 9 Pilot Baxter, who had been engaged only to make the trip with us, was discharged and left the vessel. The *Grampus* lay at Wood's Holl until September 14, when we left for Gloucester to clean and paint the vessel and make some necessary repairs. We got under way at 4.22 p. m., with a light northwesterly breeze; when off East Chop the wind was very light with the ebb-tide just beginning to run from the eastward; we went into Vineyard Haven and anchored for the night. Got under way at 5 a. m. on the 15th, with a light northwest by north breeze, but on account of the continuous light baffling winds, we did not reach Gloucester until the next day, where we anchored at 8.18 a. m.

4. COURTESIES RECEIVED.

It is proper that due acknowledgment should be made for numerous courtesies received from both official and private sources, which materially aided the successful issue of the expedition and evidenced the kindly interest of those concerned in the success of the investigation.

Foremost amongst these should be mentioned the action of the Dominion Government. By order of His Excellency, the Governor-General of the Dominion, a circular letter was sent to customs and fishery officials at Dominion ports which the *Grampus* might visit, and a copy of the document was transmitted to the Commissioner.

The courtesy thus extended by the Dominion Government was important, since it dispensed with the necessity of reporting at custom-houses on entering and leaving port, and also relieved the vessel from the payment of customary harbor dues. Following is the letter:

Ottawa, June 22, 1887.

To Collectors and Officers of Customs
and Fishery Officers of the Dominion:

GENTLEMEN: You are hereby advised that Capt. J. W. Collins, of the United States Fishery Commission schooner *Grampus*, is about proceeding to Labrador on a scientific mission for his Government, and by order of His Excellency, the Governor-General in council, the vessel named is to be relieved from the observance of any of the usual customs requirements in the direction of reporting inwards or clearing outwards or the payment of any fees ordinarily collected from foreign vessels when calling at Canadian ports.

* For further details concerning this, see notes on food-of mackerel, pages [29] [30].

It is the desire of the ministers of customs and marine and fisheries that you shall individually extend to Captain Collins all the information and assistance in your power and in every way facilitate the accomplishment of the mission in your locality.

We have the honor to be, gentlemen,

J. JOHNSON,
Commissioner of Customs.
JOHN TILTON,
Deputy Minister of Fisheries.

Special acknowledgements are due Rev. M. Harvey, of St. John's, Newfoundland, for courtesies and assistance extended to the officers and naturalists on the *Grampus*. His kindly aid and intelligent interest in the attempt to secure a collection of the remains of the great auk contributed materially to the successful issue of that important undertaking.

The American consul at St. John's, Mr. Thomas N. Molloy, gave information concerning the Funk Islands and the condition of the fisheries about Newfoundland.

At St. John's it was necessary for us to refill our water-tanks, and to do this the vessel had to be taken alongside of a wharf. The water is supplied by the city and is charged for at a stated price. The city authorities, however, very generously remitted the customary charge, and allowed us to take all the water we needed free of cost. Messrs. Job Brothers & Co. kindly permitted us to haul into their wharf to fill the water-tanks, and also sent their steam-launch to tow the *Grampus* to the dock.

A Mr. Emerson, who has some ponds filled with trout in the suburbs of St. John's, permitted our naturalists to take as many specimens as they desired to obtain.

I am indebted to Capt. J. W. Pitts, of the schooner *Terror*, of Shelbourne, N. S., whom we met at Black Bay on August 5th, for information concerning the fish and fisheries along that part of the coast which he had visited, and also for the following letter of introduction to the collector of customs at Esquimaux Point, that he gave me, but which circumstances prevented me from using:

Pinivare, August 6, 1887.

DEAR SIR: My friend, Capt. J. W. Collins, intends visiting Esquimaux Point and Mingan in aid of scientific discovery. You will please give him all the information you can. Also give the Captain an introduction to the agent at Mingan.

By doing so you will confer a favor on,

Yours, etc.,

JOHN W. PITTS.

D. B. MCGEE, Esq.,
Collector of Customs, Esquimaux Point.

M. Turbid, the light-keeper at the Bird Rocks, assisted us very materially in obtaining collections of birds. He also gave us a full series of eggs of all the species that breed there.

Acknowledgements are due Commander William Wakeham, commanding the Canadian cruiser *La Canadienne*, for presenting me with sheet charts of the region about Mingan, a matter of much importance, since our charts were on a scale too small to show the local dangers, and navigating with them as my only guide was extremely hazardous. He also assisted us in other ways, and to his interest and courteous treatment much of the success we had at Mingan is due.

Messrs. H. W. Embree & Sons, boat-builders at Port Hawksbury, C. B., kindly gave me the lines and detailed plans of a "Canso boat" built by them in 1883, and exhibited at the International Fisheries Exhibition at London. This courtesy was specially appreciated, since the plans were valuable for illustrating this type of fishing boat, which has been described in a work on fishing vessels of the world, prepared by the writer, that is now in manuscript form.

5. COLLECTIONS.

Reference is made to the reports published under the auspices of the National Museum for a detailed account of the collections secured other than the fishes and invertebrates. The results of the observations made, and which have been embodied in the reports referred to, must prove valuable contributions to the knowledge of the subjects discussed. The fishes obtained on the cruise have been identified by Dr. Tarleton H. Bean, ichthyologist of the Commission.

The marine invertebrates—chiefly forms upon which the mackerel feeds—have not yet been identified. It is, therefore, not practicable to speak definitely of the species collected. I believe it will be sufficient, however, for the purposes of this report, to show in a general way the relative abundance, in the different localities visited, of those forms which constitute the favorite food of the mackerel.

The collections of land birds, insects, botanical and geological specimens, etc., were obtained incidentally, as opportunity offered, and in several instances were of exceptional importance. Among those specially noteworthy were the rock ptarmigans (male and female), elsewhere mentioned, and some rare and new species of ferns and mosses. A complete collection, made at Funk Island, of insects, plants, geological specimens, etc., can not but prove valuable additions to our knowledge of this interesting spot.

But, considered from the stand-point of the fisheries, the collections of various species of sea-birds that prey upon fish or serve as food or bait for the fishermen were most valuable. The observations made upon the present condition of the rookeries that were examined may, however, fairly be considered even more important than the specimens obtained, since they furnish information upon which may be based

opinions as to the extermination, or otherwise, of certain species which have special relations to the prosperity of the fisheries.

Aside from the interest that may be felt by the naturalist in preventing the extinction of races of sea-birds, zoologically important and interesting, the matter of preserving their breeding-places from destruction is one of no small moment to the fisherman.

It is a well-known fact that for many years cod-fishermen upon the great ocean banks depended to a considerable extent upon birds for a bait supply. Among those thus utilized were gulls, terns, and other species that breed on the northern coasts.

It is not, perhaps, so well understood that fishermen often are benefited by that instinct that sea-birds possess in a high degree, and which enables them to quickly detect the presence of such fish as they prey upon. The writer is familiar with the fact that fishermen are careful observers of the movements of birds. The mackerel fisherman keenly watches the actions of the gannet; notes its success when diving; draws conclusions from the gathering flock as to the abundance of fish, and is governed accordingly. Many a good catch of mackerel has been due to information of the presence of large schools of that species thus imparted to the fisherman.

The little "sea-goose" (*Phalaropus*) is also an object of interest to the fisherman, who, though he may not have inquired why, has learned that large flocks of this genus appearing on the fishing-ground may be considered a "good sign" of the presence of mackerel. The "sign" is due to the fact that the phalarope, which feeds largely upon copepods and other small forms of marine life that constitute the favorite food of mackerel, is liable to be where there is an abundance to eat, hence the connection between the presence of birds and fish.

No fisher-lad is too young not to have learned the meaning of unusual noisy activity among sea-gulls and terns. There is no surer indication of the approach to the coast of the long-watched-for schools of capelin, herring, or mackerel, the van-guards of which are thus heralded by winged attendants.

Sea-birds are often a source of food supply to the fishermen. This was formerly much more frequently the case than now, for the wanton destruction of both birds and eggs has materially reduced the production of the most important rookeries.

No bird, perhaps no animal, held a more important relation in this respect to the early American fisheries than the great auk. Indiscriminately slaughtered by thousands, it made an important addition to the fisherman's larder, until at last it yielded to the rapacious and destructive agencies it was not fitted to withstand, and a most interesting species was totally wiped out of existence.

All that remains to-day in America of a once immensely abundant gigantic sea fowl is its burial-ground, and a few specimens of its eggs and mounted skins that naturalists obtained before its annihilation.

But so suddenly, so unexpectedly, and so thoroughly was it obliterated that in all the museums of the United States there was only one skeleton—more properly a dried mummified specimen—of *Alca impennis*. And with few exceptions the museums of Europe, as well as those of this country, were without any osteological remains of the species. A few bones dug from shell heaps, or accidentally found in out-of-the-way places were considered valuable prizes.

It will thus be seen that the procurement of a large collection of the remains of the great auk was a matter of special importance, whether considered from the stand-point of science or the more practical bearing of the historical relation of the species to the fisheries. The details of the magnitude of this collection, as well as many interesting facts relating to the obtainment of it, and the history of the great auk, are given in the National Museum publications for 1887–8 and need not be repeated here.

It may, perhaps, suffice to say that the collection of remains of the great auk exceeds in magnitude all others. Several skeletons have already been mounted, and Mr. Lucas is authority for stating that probably ten in all will be made. Leg and wing bones were obtained of more than 700 birds.

Among the species of sea-birds collected which are most important, so far as the fisheries are concerned, the following may be mentioned here:

Gannet (*Sula bassana*).
A large and full series, consisting of eggs, embryos, nestlings, and adults.
Arctic Tern (*Sterna paradisæa*).
A series similar to the above, with the addition of nests of various forms.
Kittiwake Gull (*Rissa tridactyla*).
A full series, including nests.
Herring Gull (*Larus argentatus smithsonianus*).
Nestlings and adults.
Bonaparte's Gull (*Larus philadelphiæ*).
Young and adults.
Razor-billed Auk (*Alca torda*).
A full series; eggs, embryos, young, and adults.
Murre (*Uria troile* and *lomvia*).
A full series; eggs, embryos, young, and adults.
Puffin (*Fratercula arctica*).
A full series as above.
Red Phalarope (*Phalaropus fulicarius*).
Adults.
Common Hagdon or Great Shearwater (*Puffinus major*).
Adults.
Black Guillemot (*Cepphus grylle*).
Young in first plumage and adults.

Besides the above, several other varieties were obtained, and in all cases, including the species above mentioned, enough specimens were secured to have a series of skins and skeletons made of all adult birds.

THE GREAT AUK (*Alca impennis*).

From mounted specimen in the Smithsonian Institution.

The following is a list of the fishes collected, as identified by Dr. T. H. Bean, who says: "Among the trout I find some interesting specimens, particularly the brook trout with hyoid teeth. The *fontinalis* usually has no hyoids, but some of these specimens have them well developed:"

Smelt (*Osmerus mordax*).
Cunner (*Ctenolabrus adspersus*).
Flounder (*Pleuronectes americanus*).
18-Spined Sculpin (*Cottus 18-spinosus*).
Brook trout (*Salvelinus fontinalis*).
Atlantic Salmon (*Salmo salar*).
Butterfish (*Murænoides gunnellus*).
Stickleback (*Gasterosteus aculeatus*).
Cod (*Gadus ogac*).
Daddy Sculpin (*Cottus grœnlandicus*).

6. NOTES UPON VARIOUS SPECIES OF FISH, ETC.

(*f*) *Mackerel.*—As has been stated, the principal object of the cruise of the *Grampus* was to investigate the matter of the occurrence of mackerel in certain places little frequented by those who fish for that species. It was also deemed important to determine, if possible, the presence or absence in the regions visited of those forms upon which the mackerel feeds.

The plan adopted to obtain information concerning the presence of mackerel was to make trials with toll-bait, and to inquire of every one liable to possess any definite knowledge of its occurrence in localities they were familiar with. The presence of minute crustacea (called "red seed" or "cayenne" by fishermen), or other small forms of surface-swimming marine animals upon which the mackerel feeds, was determined by towing small surface nets. The temperature of water and air was systematically taken at short intervals, which supplies the data for determining whether the conditions in certain localities are suitable for this species.

The first objective point was the Bird Rocks, which lie off the east end of the Magdalen Islands, in the Gulf of St. Lawrence. In former years, when hook and line fishing for mackerel was in vogue, large catches were frequently made in the near vicinity of the Bird Rocks. But this locality has been seldom visited by mackerelmen in recent years. Reports have also been circulated of the recent occurrence of schools of mackerel between the Bird Rocks and St. Paul's Island. It was, therefore, important that these localities should be visited and an effort made to determine the presence or absence of the species in that vicinity.

On the afternoon of July 9 toll-bait was thrown for several hours (long trials being made with it at intervals from noon to about 7 p. m.) a little more than a mile to the westward of the largest Bird Rock, but no mackerel were seen or taken.

M. Turbid, the keeper of the light, said he had seen no indication of the presence of mackerel about the rocks during the summer. Large mackerel were abundant in 1885, but since that date have generally been scarce, and most of the time either rare or entirely absent.

On July 10 a trial was made with toll-bait 15 miles east by north from Entry Island. No mackerel were seen or taken.

July 13 another trial was made south-southeast 4 miles distant from Entry Island without result.

As mentioned elsewhere, the conditions of the weather were unfavorable for making a comprehensive investigation between the Bird Rocks and St. Paul's Island, without delaying the trip to Newfoundland longer than was thought desirable. However, a lookout was kept for indications of mackerel, but nothing was seen which gave reason to think that any fish of that species were in the region mentioned. If mackerel had been there in any abundance, it is probable that schools of them would have been seen at night, when the presence of fish can generally be easily detected by the phosphoresence they cause in the water.

While at the Magdalens I learned that the gill-net fishermen had found mackerel exceptionally scarce during the early part of the season, and very few were obtained.

There have been for many years traditions among the fishermen of the occasional abundance of mackerel in White Bay and adjacent waters on the northeastern coast of Newfoundland. It was, therefore, deemed important to obtain as complete information as could be secured concerning the occurrence of mackerel in that region. The statements given below are based upon the recollections of various people who were interviewed, and who have been associated with the fisheries of that region for many years. The result of the inquiries made can be briefly summarized as follows:

About 1870 to 1875, and occasionally in previous years, mackerel were found at times in considerable abundance at White Bay and at Canada Bay. One or two fishermen remembered that individuals had been taken as far east as Fogo Island, but their recollection was not clear enough to make any definite statements. A marked characteristic of the mackerel taken in this region is that they are invariably poor in flesh and inferior as food. One fisherman said they are "dry as sticks."

Mackerel had seldom been seen about White Bay and vicinity for twelve years, though occasionally a specimen has been taken in the herring-nets.

On July 26 Capt. George Manuel, of the mail steamer *Plover*, who had just arrived from his trip along the Labrador coast and the "French shore" of Newfoundland, stated that he had not heard of the occurrence of mackerel on the coast of Newfoundland at any time during the summer.

The captain of a schooner which had recently arrived at Toulinguet

from White Bay, reported no mackerel having been seen in the latter locality or the adjacent coast waters.

The captain of the schooner *Phœnix*, which had just left White Bay, also reported that no mackerel had been seen in White Bay or vicinity during the summer. We hove-to off Bay Verte and tried for mackerel with toll-bait for about an hour, but without result.

We did not learn of the recent occurrence of mackerel at Canada Bay. The inhabitants seemed to have no definite recollection of mackerel having been there.

On August 4, when near Cape Norman, in the Strait of Belle Isle, we were boarded by two of the crew of the schooner *Edward Rich*, of Catalina, Newfoundland, and they said that their vessel had been in that vicinity since June 25 and had taken no mackerel, nor had they heard of any being taken, neither had they seen anything that would indicate the presence of mackerel in the Strait. One of them said that he had fished in the Strait for several successive summers, but had never known of mackerel being abundant there. Two or three years previous, he remembered that a few mackerel had been taken about Cape Norman in herring gill-nets, but they were not plentiful.

Capt. J. W. Pitts, of the schooner *Terror*, of Shelbourne, N. S., whom I met at Black Bay on August 5, said that he had cruised along the Labrador coast from the Mingan Islands to Fox Bay, beginning his cruise at the former place on May 18. He had not learned of the presence of mackerel this year in any of the localities he visited, and he had the impression that mackerel had not been abundant anywhere along that coast in many years.

In previous years he had caught mackerel with hook and line about the middle of August, in the vicinity of Esquimaux Point, at Mingan. In 1886 a few mackerel were caught at Natasquan, but he had heard of none being taken in the Strait of Belle Isle. In 1885 large but poor mackerel were fairly abundant in the strait, and Captain Pitts purchased a quantity at Red Bay of the local fishermen who caught the fish in $2\frac{3}{4}$-inch-mesh herring gill-nets. Only a comparatively small amount of mackerel were taken by the fishermen at Red Bay, and few or none at other points in the strait.

The fishermen of Black Bay, Strait of Belle Isle, agreed in saying that mackerel were abundant in the summer of 1885, from about the middle to the last of August. One skipper of a seining gang told me that he could have hauled a vessel load in one drag-seine at the head of the bay. But there was no market for them, and the few barrels which were taken from time to time could not be sold, or the price received was too low to pay for the work of curing the fish, not to speak of the labor of catching them.

Here, as on the "French shore" of Newfoundland, there was a remarkable consensus of statement to the effect that the mackerel taken are generally of large size, but always poor in flesh and of little value as food.

Mr. W. A. Stearns makes the following record of the appearance of mackerel on the Labrador coast:

"Seldom taken at all on the Labrador coast, except as isolated individuals or by twos or threes. One person at Triangle Harbor took eight while we were there, but said that he had not taken as many before in as many years." *

When at Perce, on August 21, I learned that there had been no body of mackerel in that vicinity during the summer. Occasionally a single individual had been taken in the herring gill-nets, but none were seen schooling, and the scattering specimens caught only emphasized the absence of the species from this region, which was formerly an excellent fishing-ground.

Off East Point, Prince Edward Island, we were intercepted by the schooner *Moro Castle*, of Gloucester, Mass., the captain of which was anxious to learn what news we had of mackerel on the "north shore." I learned from him that his vessel had taken 140 barrels of mackerel, chiefly on Bank Bradley, soon after his arrival in the Gulf of St. Lawrence, but for four weeks he had not caught a fish. Some of the small boats were doing fairly well at hook and line mackerel fishing close inshore, on the north side of Prince Edward Island, and at Cheticamp, Cape Breton. Canadian vessels had, however, been no more fortunate than American schooners. None of the seiners had met with any success for several weeks. Altogether the season had been a very unprofitable one for mackerel fishermen.

The negative results obtained in our investigation relating to the mackerel along the east coast of Newfoundland and the shore of Labrador, proved beyond question that there were no mackerel in those regions in the summer of 1887, up to the time that we visited the coast. There is also reason to think that mackerel occur there less frequently and in less abundance than is generally believed. In view of the fact that all evidence goes to prove that the species is remarkably poor in northern waters, it would seem to be a non-profitable undertaking to pursue them thither even were there a greater probability of finding fish plentiful. The cause of their poor condition is probably due to the fact that the temperature of the water is lower than it is on the grounds where mackerel fatten rapidly, and it is possible that they find in those regions comparatively little food which is suited to them.

There is a popular belief that when mackerel are scarce off the shores of the United States and in the Gulf of St. Lawrence they must be abundant elsewhere. This belief may be well founded in the abstract, but there is no evidence to prove that the scarcity of fish in the Gulf of St. Lawrence is any indication that they may be found farther north. As a matter of fact, mackerel were exceptionally scarce on the gulf fishing-grounds during the summer of 1887. Commander William

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*Proc. U. S. National Museum, Vol. VI, 1883, p. 124. "Notes on the Natural History of Labrador."

Wakeham, inspector of fisheries for the Province of Quebec, states that "mackerel were scarce all over this division, although a few of very fine quality were caught at Magdalen Islands; the bulk of the mackerel schools kept about Prince Edward Island and Cape Breton never coming northward across the gulf."

The inspector of fisheries for the Province of New Brunswick, Mr. W. H. Venning, reports "that this fishery was a failure. From 17,868 barrels and 70,128 cans last year, the catch has fallen to 3,607 barrels and 44,278 cans this year." The inspector of fisheries for the Province of Nova Scotia stated in his report that the catch of mackerel in that province had been some 10,000 barrels less than the previous season. The catch at Prince Edward Island was 3,872 barrels less than in 1886.

(*g*) *Food of mackerel.*—The presence of mackerel in any particular locality is doubtless due to a considerable extent to the abundance of food which is specially attractive to them. As is well known, the mackerel feeds with avidity upon small copepods, generally of a pinkish tint, and for this reason frequently called "red seed" or "cayenne" by the fishermen. All observations made hitherto have led to the belief that this form of life is the food which the mackerel is particularly fond of.

From the time the *Grampus* left Gloucester until she returned attempts were made to ascertain the presence or absence of crustacea, or other small forms of life at the surface of the water, by towing a small fine-meshed net specially designed for collecting minute animals. Elsewhere the results of these towings are tabulated and specifically set forth; here I intend only to consider in a general way the bearings upon the fisheries of the results obtained. Practically without exception, nothing was taken in the towing nets which could serve as food for mackerel from the time we entered the Gulf of St. Lawrence until we passed through Canso on our way home. The gulf, the coast of Newfoundland, and the waters along the shores of Labrador appeared to be utterly barren of such minute forms of life as the mackerel feeds upon, though it may be mentioned that a few specimens of crabs in their larval stages were taken off the northeastern coast of Newfoundland. But in the Gulf of Maine, and along the south coast of Nova Scotia, small crustacea were found in considerable abundance, and frequently in great numbers. On our return voyage we found them specially numerous in the Gulf of Maine. This led me to believe that mackerel would be more abundant in the fall off the New England coast than in the Gulf of St. Lawrence, especially as Captain Nauss, of the *Moro Castle*, had stated that he had seldom seen any food in the stomachs of the mackerel taken in the last-mentioned locality during the early part of the season.

Upon my arrival at Gloucester after completing the cruise, I was interviewed by Wm. H. Jordan, of the firm of Rowe & Jordan, who own several mackerel schooners, as to the probability of their vessel, which was then in provincial waters, getting a good catch of mackerel.

In reply to his inquiries I ventured the opinion that fish would, in all probability, be caught off our own coast in greater numbers than in the Gulf of St. Lawrence. The correctness of this opinion may, perhaps, best be shown by the following letter from the firm, which explains itself:

GLOUCESTER, MASS., *September* 29, 1887.

SIR: You may remember about the first of the month we asked you if you could give any information about the prospect of finding mackerel in or about the Gulf of St. Lawrence and adjacent waters. You said during your trip there in the schooner *Grampus*, from which you had just returned, you had observed very carefully all signs tending to show the presence of mackerel in any considerable quantity, and had not found any, and furthermore, you had kept a drag-net out all the time you were sailing and had found absolutely no food for mackerel until upon your return trip you had got nearly home, on Brown's Bank or this side of it, and there you found food in large quantities, which you considered to be a reasonably sure prospect, if mackerel were caught at all, they would be caught upon our own shores; which judgment has proved accurate and very valuable. On the 7th of September, a few days after our conversation with you, we received a dispatch from Captain Cameron, of our schooner *Gatherer*, at Souris, Prince Edward Island, asking for instructions how to proceed, saying the prospect looked to be fair there. Acting upon your opinion, we directed our captain to come home immediately. He started seven days later and caught 350 barrels of mackerel 8 miles from Eastern Point, in Massachusetts Bay, and they were sold for $18 per barrel; the 130 barrels he had on board, caught in Bay St. Lawrence, were sold for $13.50 per barrel, and he had been ten weeks catching them.

* * * * * * *

Truly yours,

ROWE & JORDAN.

Capt. J. W. COLLINS,
U. S. Fish Commission, Washington, D. C.

(*h*) *Cod.*—As has been stated elsewhere, the obtainment of information concerning the cod, and the fishery which is based upon it, in the regions visited, was thought to be of secondary importance. However, occasional trials for cod were made with hand-lines, and inquiry was made concerning the cod-fishery at the places visited. At the end of this chapter, and in Table II, may be found a summation of the trials with hand-lines and the results obtained, so far as cod are concerned. Also, in "Notes concerning the Newfoundland cod-fishery," the reader will find details of vessels, apparatus, methods, etc. Here I propose to discuss the condition of the fishery in a general way, giving in substance the result of our investigations, so far as they bear upon the status of this industry in 1887, at the places visited by the *Grampus*.

In former years there was an important cod-fishery about the Magdalen Islands, which, in addition to a numerous fleet of boats that sailed from various harbors, also drew thither a fleet of vessels of greater or less proportions. Most of these vessels were from British provincial ports, some that sailed under the French flag came from Miquelon, and not unfrequently American schooners formed a portion of the fleet. Usually these vessels fished "at a drift" on the shallow rocky spots about the islands, and generally they were successful.

In recent years the fishery has materially declined in importance. A fleet of boats is still employed from the islands, but it appears that fewer vessels now visit that region to fish for cod.

In the various trials we had with hand-lines about the Magdalens the results obtained showed that cod were very scarce. M. Turbid said they have not been abundant at the Bird Rocks in recent years. This statement was verified by three of the crew of a cod-fishing schooner whom I met on the smaller Bird Rock, which they had visited to shoot birds for food. Their vessel lay in the offing "drifting" for fish on a shallow spot between the Bird Rocks and Byron Island. They had tried for fish on nearly all the grounds around the Magdalens, they said, and without exception had found cod very scarce. Indeed, they were emphatic in declaring that unless they were more fortunate than they had been their voyage would be a failure.

The shore cod-fishery on the coast of Newfoundland, from St. John's around to the Strait of Belle Isle, has been in an unsatisfactory condition for several years. In many of the bays, where an extensive and remunerative cod-fishery was formerly maintained, the cod has been so scarce in recent years that only meager results could be obtained, and the coast fishermen have been reduced almost to starvation in some localities.

During the summer of 1887 the cod-fishery was in a very deplorable condition on the northeast coast of Newfoundland. In the region from Fogo Island to Canada Bay many of the fishermen had obtained little more than enough fish for their own tables.

On July 25 a fisherman at Seldom come-by Harbor told me that he had not caught, up to that date, more than one-half quintal of cod. Similar statements were made by others. At Toulinguet I was informed that a gang of four men operating a trap had taken only 3 quintals of cod. A few small fish were generally the result of a day's fishing for a man, the amount being scarcely enough for the consumption of his own family. At Canada Bay the same story was told. The fishermen were disheartened. Day after day they went to the fishing grounds with their boats and still no results. They had experienced a year or two of special privation on account of the scarcity of cod, and as fish is their only dependence they were next to hopeless. A French schooner that lay in one of the coves in Canada Bay, about 5 miles from where we anchored, had been fishing all summer and getting next to nothing. We made several trials with hand-lines, but caught no fish.

What this exceptional scarcity of cod is due to no one seems able to tell. Various causes are assigned, but they are generally without proper foundation. The fishermen, at least those who have any knowledge of fish culture, hope that some remedy may be found in the artificial propagation of cod.

The scarcity of cod around the coast of Newfoundland in recent years has led to a considerable change in the fishery. Instead of depending almost entirely upon inshore fishing, the tendency in recent years has been to engage more extensively in the offshore bank fishery, and this has also lately come to supersede, to some extent, the Labrador coast fishery. As a matter of fact, the condition of the Labrador cod-fishery has been nearly as bad as that on the northeast coast of Newfoundland.

On July 26, when I met Captain Manuel at Toulinguet, he reported that the catch of cod on the Labrador coast, up to that time, had been very meagre. The fleet had not got beyond Battle Harbor on account of ice, and there was much anxiety felt by all concerned in the fisheries as to the outcome for the season. Many feared that the cod-fishery would be almost a total failure. In the early part of August, when we were at the Strait of Belle Isle, the prospect was little if any better.

It is possible that in future years the cod-fishery of the Labrador coast and eastern Newfoundland may regain something of its former importance. But there is reason to believe that, at least for many years, it will not be of sufficient proportions to offer any inducement for American fishermen to engage in it, if, indeed, the catch is sufficient to maintain the coast population and prevent semi-starvation.

The cod-fishery at Mingan and adjacent localities had been fairly prosperous, though the fishermen had met some difficulty in obtaining a full supply of bait. The fishermen at Perce were disposed to complain somewhat of a scarcity of cod, but from all that could be learned I inferred that the season's catch had been pretty well up to the average. The conclusion arrived at is sustained by the following, extracted from the report on the fisheries of the province of Quebec, by Commander Wakeham:

"Cod-fishing began late, it being the 10th of June before the fish struck in. The yield was about the same as in 1886, with a difference of 3,050 cwts. in favor of this season. The catch was large about the end of June and beginning of July, and every one looked forward to an unusually successful fishery, but during August and September bait became uncertain, and in October and November the weather was so rough that it became impossible to carry on the fishery. When the weather was fine and the boats could go out, fish were found abundant everywhere. It was noticed this year that cod went higher up Bay des Chaleurs, and in greater quantities than for many years past. The same fact was noticed on the north shore; for many years, say fifteen at least, no cod has been taken above Point des Monts; this season fish were abundant right up to the Manicouagan. It is generally

conceded that cod were never more abundant inshore than they were this year. On the upper part of the south shore, from Cape Magdalen to Cape Chatte, cod-fishing was again spoiled by the appearance of white porpoises, which came down the river during the summer months and drove the cod from that part of the coast.

"The catch of cod on the Labrador coast was again small, only 22,717 cwts. having been taken below Natashquan. The fish keep in deep water offshore, and were all caught with hook and line, nothing being done with 'twine,' which is an expression used to indicate the fishery carried on with seines, traps, and gill-nets.

"On the upper north shore, from Mingan to Point des Monts, the summer fishery was fair, the large rooms at St. Johns, Magpie, and Sheldrake making better returns than for some years past."

(*i*) *List of trials for cod.*—July 6. A trial with hand-lines was made off White Head, N. S. (White Head bearing northeast about 5 miles distant), and four small cod were taken on one line in an hour's fishing.

July 9. Tried for cod southwest by west $\frac{1}{2}$ west $1\frac{1}{4}$ miles from the larger Bird Rock, but caught no fish.

July 10. Put out hand-lines 15 miles east by north from Entry Island. Caught eleven cod, one small halibut, and two flounders.

July 13. Tried with hand-lines south-southeast from Entry Island about 4 miles distant. Caught five small codfish and one small halibut in about an hour.

July 22 and 23. Tried with hand-lines on the shoal east-southeast about one-half mile from Funk Island, Newfoundland. Caught nothing.

July 28. Southern end of Pigeon Island, Newfoundland, bearing southwest by west $\frac{1}{2}$ west, about 5 miles distant, put out hand-lines and tried for nearly an hour and caught no fish.

August 9. On northwestern part of Natashquan Bank (lat. 49° 52′ N., long. 60° 21′ W.) in 51 fathoms of water, tried with hand-lines for cod. No fish were taken.

August 10. Off Mingan Islands, the large island bearing north one-half east, about 4 miles distant. Put out hand-lines and caught one cod.

August 21. Cape Gaspé bearing north, Percé bearing west-northwest. Tried with hand-lines for cod in 50 fathoms of water. Nothing was caught.

August 30. Seal Island ground (lat. 42° 58′ N., long. 66° 06′ W.) in 60 fathoms of water. Tried with hand-lines and caught one cod and one cusk.

(*j*) *Swordfish.*—There is reason to believe that swordfish sometimes find their way even as far north as eastern Newfoundland. Mr. Andrew Linfield, of Toulinguet, stated that swordfish have occasionally been seen along that coast. The capture of a fish of this species is, however, considered a remarkable occurrence.

(*k*) *Halibut.*—It was my original intention to make a series of trials for halibut in depths varying from 100 to 200 fathoms off the northeast coast of Newfoundland, and especially to the eastward of Belle Isle and Cape Bauld, but the detention at Canada Bay, the probability of the occurrence of fog, and the fact that numerous icebergs were drifting about in the vicinity deterred me from carrying out this part of the plan. As will be seen by reference to the narrative of the voyage, it would have been impracticable to carry on any fishing for several days after we reached the Strait of Belle Isle, where we were detained by a gale.

The prevalence of unfavorable weather, the difficulties attending the obtainment of a supply of bait, and the time occupied in an effort to obtain specimens of the gray seal at Mingan, prevented the investigation and trials for halibut which I contemplated making in the vicinity of the Mingan Islands. It is to be regretted that the advance of the season and the consequent uncertainty of the weather offered little encouragement for a longer stay.

It is worthy of mention, however, that experiments made in keeping halibut alive in the well were satisfactory, and there is reason to believe that no special difficulty would be experienced in bringing halibut alive to Wood's Holl from the Gulf of St. Lawrence unless they should die from change of temperature. The two small halibut taken off the Magdalen Islands on the 10th and 13th of July, each lived in the well for several days. When they were taken out for cooking, about a week after they were put in the well, they seemed as vigorous as when they were put in and there were no indications of injury.

(*l*) *Capelin.*—So far as could be learned capelin occurred in their usual abundance along the shore of Newfoundland and Labrador, where they are extensively used for bait, and also for food, being dried or salted in greater or less quantities by the fishermen for winter use. They are also fed to hogs. The capelin season was practically over when we reached the coast. While we were at Mingan, on August 18, an attempt was made to collect capelin to bait our halibut trawls. The spawning season was over and they were daily growing less abundant along the shore. Occasionally a few would run in near the surf. We obtained about 1½ bushels, of which mention is made elsewhere. At the time of our arrival at Mingan, on August 11, capelin were moderately abundant, sufficiently so for the fishermen to get all the bait they wanted.

(*m*) *Lobsters.*—The lobster fishery is an important industry in several places which we visited. There are a number of canneries on the Magdalen Islands, where the packing of lobsters has been carried on for several years. There is, however, a complaint of the growing scarcity of this highly-prized crustacean, and, judging from what I was told, the fishery will soon decline unless some means are adopted to prevent over-fishing. A gentleman at Grindstone Island, who is the manager of a lobster cannery there, stated that lobsters had decreased in size

and abundance very rapidly within the previous two years. He thought this was true generally of the Magdalen Islands.

Another, who operated a cannery at Amherst Harbor, said his pack for 1887 would not exceed one-quarter of the amount which he put up three years previously. He thought the outlook for the lobster fishery very discouraging unless something was done to check over-fishing. He stated that the catch of lobsters was of the greatest consequence to the fishermen of the Magdalen Islands, for the reason that cod were scarce, that the spring mackerel-fishery had been a failure, and that, although spring herring were abundant, there had been little demand for them.

Lobsters appeared to be plentiful on the east and northeast coasts of Newfoundland. Numbers of fine ones were brought alongside the *Grampus* at Seldom-come-by Harbor, which the fishermen were glad to sell at a nominal price. I learned that there was a cannery at Fogo Harbor, but it had not sufficient capacity to utilize all the lobsters that could be easily obtained there. Canneries have been erected at other points along the coast south of Fogo, but we did not learn of the existence of any west and north of that place.

Mr. John Holmes, light-keeper at Seldom come-by Harbor, said that lobsters were abundant and of large size at that place, but that the fishermen could find no market for them, since the cannery at Fogo received its supply from the fishermen at that harbor.

So far as could be ascertained, the northern limit of distribution for the lobster appears to be about the Strait of Belle Isle. I was told that occasionally a lobster would be taken on the south side of the Strait, but that one was seldom or never seen on the north side.

It is reported that lobsters are abundant on the west and southwest coasts of Newfoundland. If the reports are true, it is very possible that a profitable industry might be carried on by American vessels on that part of the coast where they have a treaty right to fish in littoral waters. The lobsters could be brought alive to the United States in welled smacks, or they could be canned on board a vessel, which might be fitted up temporarily as a floating cannery.

(*n*) *Whales.*—On July 16 eight humpback whales were seen; two of them to the southwest of Cape Pine; two between Cape Pine and Cape Race, and four others to the northeast of the latter point.

Several whales were seen off Canada Head on July 29.

A small finback came into the harbor near the vessel on several occasions while we lay in Canada Bay, usually making its appearance near sunset.

North of Groais Island and Cape Rouge, on August 3, and between that point and Cape Bauld, humpback and finback whales were seen in abundance.

During the afternoon of August 10, while off Mingan, a number of whales were seen; their appearance being particularly noticeable on account of their closeness inshore.

A pike whale (*Balænoptera?*) was feeding near the vessel in Mingan Harbor on August 14. An attempt was made to capture it; a bomb-lance was fired at it, but going wide of its mark only frightened the animal so that it soon left the harbor.

(*o*) *Porpoises.*—Porpoises appeared to be abundant off northeastern Newfoundland, but no effort has been made by the local fishermen to capture them for commercial purposes. Among those noticed were the dolphin or common "sea porpoise" (*Delphinus delphis*), the porpoise (*Tursiops tursio*), and puffing pig (*Phocæna communis*). We saw them off a long stretch of coast, and they appeared to be specially numerous at Canada Bay and vicinity. They were very shy, however, and it was impossible to approach them close enough to secure them by harpooning or shooting. I think there would be no difficulty in securing them if the proper means were adopted. But the fishermen said that there is no demand either for porpoise-oil or skins, and therefore there was no inducement for them to make an effort to catch them.

We made numerous attempts to capture specimens, but without avail. At 6.30 a. m. on July 22, about 15 miles southwest of Funk Island, a school of porpoises came around the vessel. One was harpooned, but the iron did not get a good hold, and pulled out before the vessel could be brought to the wind.

On July 29 we saw a great number of porpoises outside of Canada Head, but they avoided the vessel, and seemed to be intent chiefly on chasing squid or capelin. Almost every day, while we lay at Canada Bay, porpoises were seen in the bay and harbor. We went out in boats and tried to harpoon or shoot them, but their extreme shyness prevented us from getting near enough to make any captures.

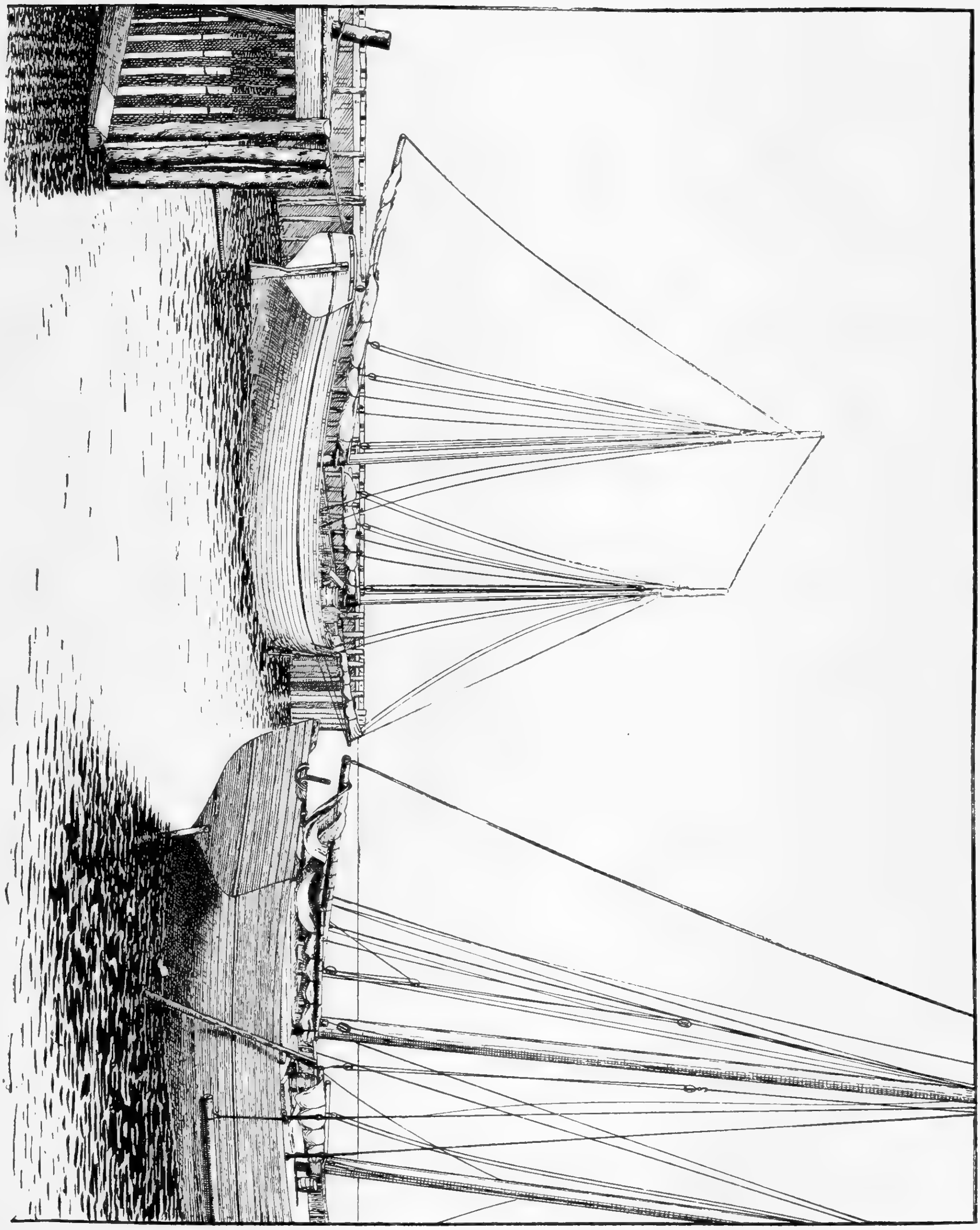
On August 3 porpoises were abundant north of Groais Island and Cape Rouge, and were also seen between those points and Cape Bauld.

(*p*) *Giant squid.*—Mr. Andrew Linfield states that a giant squid was captured in 1885 between Chance Island and Toulinguet by the fishermen at Herring Neck. The captors, not knowing that the animal had any value except for bait or manure, destroyed it before any one better informed knew it had been taken.

7. NOTES UPON THE OCCURRENCE OF HAGDONS.

On July 16, when off Cape St. Mary and Cape Pine, we fell in with numerous large flocks of hagdons (*Puffinus major* and *P. stricklandi*) setting upon the water. The sooty shearwater, or black hagdon, was here in much greater relative abundance than I have ever previously seen it. In most cases it seemed fully as numerous as the great shearwater (*P. major*), and occasionally even more abundant. It will probably not be incorrect to say that nearly 50 per cent. of the birds seen during the day, from Cape Pine to Cape Race, were of the black variety.

The day was fine with light wind, varied by periods of calms, thus



NEWFOUNDLAND FISHING-SCHOONERS. THE GALLOPER ZEPHYR AT THE WHARF. (See page [40].)

Drawn by E. I. Rogers.

affording an excellent opportunity to note the flocks of hagdons and the relative numbers of each species.

The birds appeared to be gorged with food, which was probably the case, since they had doubtless been feeding to repletion on capelin that were abundant along the coast. With rare exceptions, the flocks sat quietly upon the water, unless disturbed by the approach of the vessel. But I noted that the birds were exceptionally shy. This was remarkable, for the hagdon, especially *P. major*, is generally easy to approach, and when hungry is quite indifferent to the presence of man or boat, at least it will venture within a few feet of either. On this occasion, finding it difficult to get within gunshot with the vessel, the attempt was made to approach the flocks in a boat, but this failed, as did the effort to attract the birds with cod-livers. It was, therefore, evident that the "hags" were sated with food, and the fact was demonstrated beyond doubt that these species, which are among the most daring and venturesome of all wild fowl when prompted by a desire for food, appreciate the danger of the near approach of man and grow circumspect, if not timid, in exact proportion as their stomachs become filled.

Hagdons were quite frequently seen from Cape Race to the Strait of Belle Isle, but nowhere in such abundance as between Cape Race and Cape Pine; indeed, they were generally scarce and sometimes rare. In all cases, however, the black hagdons seemed proportionately more numerous than I have ever seen them on the banks, and the inference would be that this species prefers to remain near the coast.

8. ICEBERGS.

On July 16 an iceberg was seen about 5 miles to the southward of Cape Pine, apparently aground. I estimated that it was about 50 feet high above the water.

On July 20 a large berg was seen north of Baccalieu Island. The same evening two large bergs were passed about 2 or 3 miles north of Gull Island off Cape Bonavista. These bergs were estimated to be about 50 to 60 feet high, and apparently were grounded. There were evidences that one had recently rolled over, as there were marks of the bottom upon its sides, and masses of broken ice drifting to leeward. Several small bergs were seen the same day off Catalina Harbor.

On July 22 and 23 several small bergs were seen in the vicinity of Funk Island, north of it, and one or two between Funk Islands and Fogo Island. The height of these was estimated to vary from 15 to 40 feet.

Between July 26 and 29 scattering bergs were seen between Fogo Island and Canada Bay. On the morning that we left Toulinguet, July 28, we passed two icebergs off West Shag Rock, and later passed another and larger berg north-northwest (mag.) from Toulinguet light. Saw a moderate-sized berg east-northeast from Cape St. John's. It was close inshore and apparently aground.

There was a small berg in Canada Bay when we entered, opposite Otter Cove, and it remained there until we left, though its size had apparently decreased in the mean time. It was probably 20 feet high.

On the afternoon of August 3 three icebergs were seen between Belle Isle and Groais Island. Later on the same day a large berg was seen northeast of the northern end of Groais Island. I estimated that it was fully 500 feet long at the water's edge and 100 feet high. It was apparently smooth and level on top, and had no pinnacles around its edges. Other scattering bergs were also seen north of Cape Rouge, and between that and Cape Bauld.

On August 4 we saw eight icebergs off Cape Norman in the Strait of Belle Isle. These were generally of small size, varying from 15 to 40 feet in height. While beating through the strait we counted in all twenty-two bergs from Belle Isle to Black Bay. None were seen to the westward of that point.

9. NOTES REGARDING THE USE OF THE CLUB-TOPSAIL.

The question of improvement in the build and rig of fishing vessels is one that has demanded the earnest attention of the Fish Commission for several years. For this reason it was deemed important that a club gaff-topsail should be made for the *Grampus*, and tried on her summer cruise to the eastward, in order that an opportunity might be afforded to study its effect upon the vessel, and from which conclusions could be drawn as to its utility for sailing schooners engaged in the market fishery. There was, of course, an additional reason (and one that deserves consideration) for having the sail, namely: The fact that the *Grampus* was going on a cruise in regions where fogs are prevalent and where some of the harbors are not lighted and are unprovided with other guides for approach. It is, therefore, of the greatest importance for a vessel cruising there to be provided with large light sails in order that she may make a port and thus complete her passage before she is overtaken by fog or by darkness, since it is dangerous and sometimes absolutely impracticable to enter many harbors at Newfoundland or Labrador after night or during the prevalence of dense fogs.

The club-topsail was frequently used, and was found to be of great service, so far as increasing the speed of the vessel in light winds was concerned, either when running free or close-hauled, and its use on several occasions enabled us to make a harbor when otherwise it would have been impracticable.

There was a little difficulty at first in handling the sail, because of the lack of experience on the part of the crew, but when the men had become more skilled in the manipulation of the sail this difficulty disappeared.

The conclusion reached is that a properly made club gaff-topsail would be of great service to vessels engaged in the fresh-fish market fishery in summer, when they are constantly making passages from the fishing

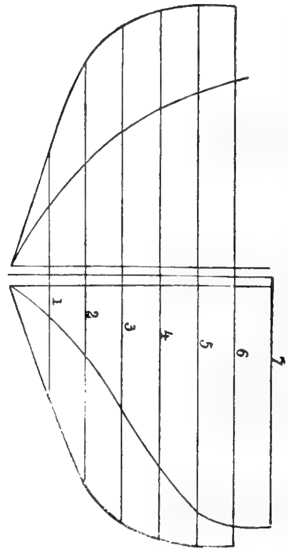


Fig 1.

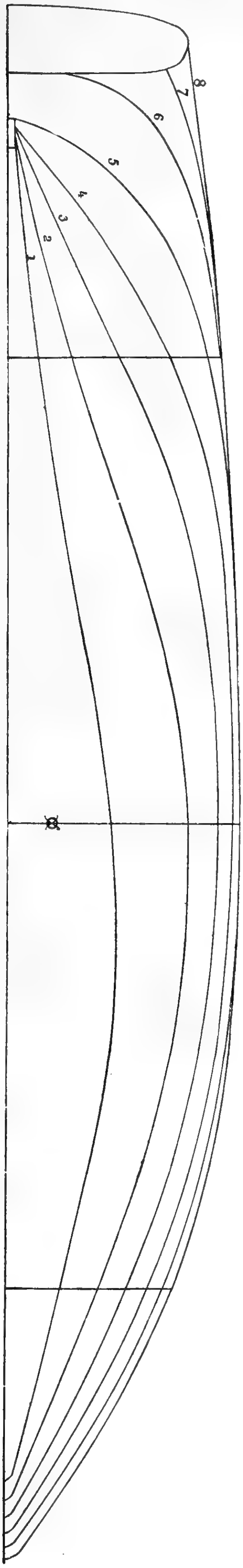


Fig 2.

Fig. 1. Body plan.

PLANS OF SCHOONER MITCHIE. (See page [42].)

Fig. 2. Half-breadth plan.

Drawn by Josiah Manuel

grounds to port in light winds and with perishable cargoes on board. It goes without saying that such a sail is not so easily managed as a working gaff-topsail. But with the large crews carried by fishing vessels there could be little trouble experienced in handling a club-topsail as soon as the men became skilled in its management. It is also probable that a spinnaker would be found very serviceable on market fishing vessels in summer, since such a sail would unquestionably increase the speed when running free in light winds.

10. NOTES CONCERNING THE NEWFOUNDLAND COD-FISHERY, ETC.*

The notes here presented, though they were gathered in a more or less random manner, as circumstances permitted, may, perhaps, prove interesting to the extent that they throw some light on the craft engaged in the cod-fishery, and the methods in vogue at the places visited by the *Grampus*. They are, to a large extent, supplementary to the observations concerning the cod, etc., in a preceding paragraph.

(*q*) *Vessels and boats.*

(1) *Schooners.*—Practically all the vessels employed in the cod-fishery of Newfoundland are schooner-rigged. Many of the old-style "jacks" and "gallopers" or "western boats" are still seen fishing near the land, and these sometimes go to the Labrador coast for a fare of cod. We met one at Canada Bay of only about 15 tons, that was on her way to Labrador. The bank fleet is composed of a different class of vessels, some of which have been purchased from the United States and Nova Scotia, while others have been built in Newfoundland.

The jack and galloper differ chiefly in size. The jack varies from 5 to 15 tons; is schooner-rigged, carrying three sails as a rule, and occasionally having an additional flying stay-sail that sets from the mast-heads, there being no top-mast. It is a full-bowed, clumsy-looking keel craft, with long rounded floor, short run, and heavy, square stern without any overhang, the rudder being outside and operated by a tiller. There is no billet-head or gammon-knee; the construction is rough and the hull is often covered with coal-tar instead of paint. The largest jacks are usually decked, with a little trunk-cabin aft, but the smaller ones have a raised half-deck forward, under which is a diminutive cuddy, dark and dingy,—a veritable "black-hole,"—aft of which are standing-rooms or "pits" where the fishermen stand to fish. The middle space is usually decked or loosely covered, and this is the fish-room, aft and forward of which the "pits" are located.

The masts are often not supported except by the jib-stay. Even the larger galloper seldom has more than a single shroud on a side to each mast, and that is usually slack, the fishermen being prejudiced against having the standing rigging taut. The masts generally rake a good deal, particularly the mainmast, which, not being supported by a stay,

bends aft considerably at the head so that it often has a very marked curve. The sails are baggy, often made of hemp duck, but cotton canvas is coming into more general use. A jack of 30 feet in length will be about 10 feet wide and 4 feet deep.

The following are the details of a so-called galloper, the *Zephyr* (built at Placentia Bay in 1878), which was seen by the writer lying alongside a wharf at St. John's (see plate V).

She is a carvel-built, decked, keel craft, with a rather full bow above water, but finer below; raking curved stem, a sharp floor, round bilge, rather easy lines aft, no overhang to counter, and a raking heart-shaped, square stern; the rudder is hung outside and is worked by a short tiller. She has a good sheer, is flush-decked, with bulwarks and rail. Her general appearance, so far as the hull is concerned, indicates good sea-going qualities, and a fair amount of speed. With the addition of a more graceful rig, a projecting cut-water or head, and an overhanging and well-formed stern, she would compare not unfavorably with many of the small vessels built in the United States a few years ago, and would doubtless surpass them in some highly requisite qualities.*

She has a windlass just abaft the foremast, which is worked by a crank. Under deck, forward, is the forecastle, a rudely constructed apartment, unpainted, with three bunks. The fire-place and chimney are built in the most primitive manner of slabs of rock, so discolored now by soot and smoke that it is difficult to tell the character of the material. The chimney is surmounted on deck by a large wooden funnel, and on each side of this is a hatch ($3\frac{1}{2}$ by $3\frac{1}{2}$ feet) which serves as an entrance to the forecastle, the lee hatch being generally closed and the weather one used when the vessel is at sea. The coamings of these are only 3 inches above deck, and in rough weather it is probable that the forecastle is anything but dry and comfortable. There are numerous hatches, which afford entrance to different parts of the hold, where are stowed various kinds of fish, bait, etc. The main hatch (5 by $4\frac{1}{2}$ feet) is situated between the masts. Immediately abaft the mainmast is a double hatch, its total length being 5 feet 8 inches, and width 3 feet 10 inches. Aft of this and just forward of the trunk is a large hatch extending almost the whole width of the deck, it being 10 feet long athwartships, and 2 feet 9 inches fore and aft. Many of these boats also have another small hatch on the port side of the mainmast, through which entrance is gained to the bait-pen, where herring, etc., are kept,

* This little schooner enjoys a good reputation, not only for sail-carrying power and safety in a sea-way, but also for speed, if we accept the statements of her skipper, who claims to have made some rather quick runs in her along the coast when, of course, the conditions were favorable. On one occasion he states he ran from St. John's harbor to Cape Race—a distance of about 58 miles—in six and one-half hours, and another time from St. John's to Baccalieu—a distance of about 31 miles—in four hours.

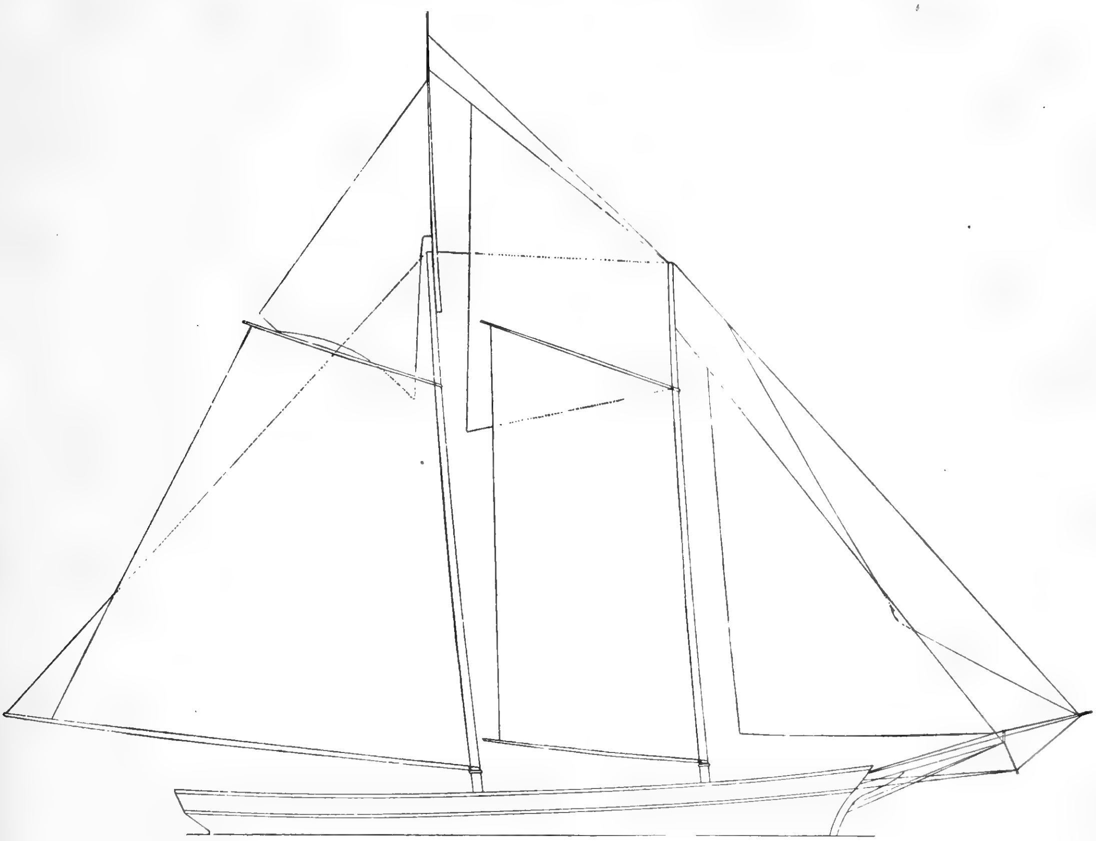


FIG. 1. SAIL PLAN OF SCHOONER MITCHIE. (See page [42].)
Drawn by Josiah Manuel.

FIG. 2. SAIL PLAN OF TOULINGUET BOAT. (See page [49].)
Drawn by J. W. Collins.

either iced or salted. There is a small trunk-cabin aft, with two berths. It is a small unpainted apartment, dingy, and not specially inviting. The bunks are cased up and each has an oblong hole for an entrance, very much after the style of berths on English fishing smacks. The trunk is 5 feet 4 inches forward of the taffrail; it is 6 feet long, 6 feet 4 inches wide at forward end, 5 feet 9 inches wide at after end, and about 15 inches high. There are two wooden pumps just abaft the after-hatch, between it and the long hatch forward of the trunk. Ordinary iron-stocked anchors are used, these weighing 175 and 400 pounds respectively. This vessel has chain cables.

The *Zephyr* is schooner-rigged, with long, round mastheads, no topmasts, and a single jib. There are two shrouds of hemp on a side to each mast, but the masts are loosely stayed and curve aft. A boom and gaff mainsail and foresail and a single jib are carried. These sails are hemp, generally oiled or barked, and are, usually, on all craft of this kind—jacks and western boats—very baggy and untidy looking, with hollow leaches and peaks at varying angles. There are three reefs in the mainsail and foresail and one reef in the jib. Old style, rope-strapped, wooden-bush blocks are used.

The following are additional details of construction: The frames are made of birch and spruce. The floor timbers mould about 6 to 7 inches. Birch plank 2 inches thick are used on the outside and for the ceiling, white pine for deck, spruce for spars. The vessel is fastened with black iron and juniper treenails.

Her dimensions are: Tonnage 29½ tons; carrying capacity 400 quintals of fish;* length, over all, 51 feet 6 inches; outside the knight-heads to foremast, 9 feet; between masts, 18 feet 9 inches; mainmast to after part of taffrail, 21 feet 6 inches; beam, 15 feet; width of stern, 9 feet; depth in hold, 6 feet 8 inches; bowsprit, outside of knight-heads (it extends inboard nearly to foremast), 16 feet 8 inches; foremast, above deck, 40 feet (head about 6 feet), 14 inches diameter at deck; mainmast above deck, 42 feet 6 inches; same diameter as foremast; foreboom, 18 feet 9 inches; foregaff, 18 feet 5 inches; main boom, 34 feet 4 inches; main-gaff, 19 feet 9 inches; tiller, 4 feet.

Vessels of this size and class are employed in the fisheries along the west coast of Newfoundland, and to a less extent elsewhere. They are manned by 5 to 7 men and boys.

The modern home-built fishing schooner of Newfoundland is generally designed in imitation of the clipper vessels of New England. It differs from the latter, however, in usually being wider and somewhat deeper in proportion to length, in being built of inferior wood, with a rough finish, and in having sails not so well cut and tidy looking. The size varies from 25 to 60 or 70 tons.

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* I give the tonnage, carrying capacity, and some other data, particularly that relating to the materials used in construction, on the authority of the captain from whom I obtained these statements. The other dimensions are from actual measurements made by myself.

The schooner *Mitchie*, built at Exploits Bay, is a representative of the most modern and approved type of vessels employed from Newfoundland in the Bank and Labrador cod-fisheries.

The following details of the above-mentioned vessel have been furnished by her builder, Mr. Josiah Manuel:

The outside planking and ceiling are birch and juniper, $2\frac{1}{2}$ inches thick on bottom and 3 inches thick on top side. The deck planking is white pine. The frames (or "body timbers") are birch, spruce, and juniper, sided $8\frac{1}{2}$ inches at throat, 7 inches in bilge, tapering to 5 inches at head; moulded 8, 9, and 10 inches. The beams side from 8 to 10 inches, and mould $8\frac{1}{2}$ inches in center and 6 inches at ends; keel $8\frac{1}{2}$ inches wide.

The principal part of the standing rigging—all the heaviest stays and shrouds—is hemp; the small stays are wire rope.

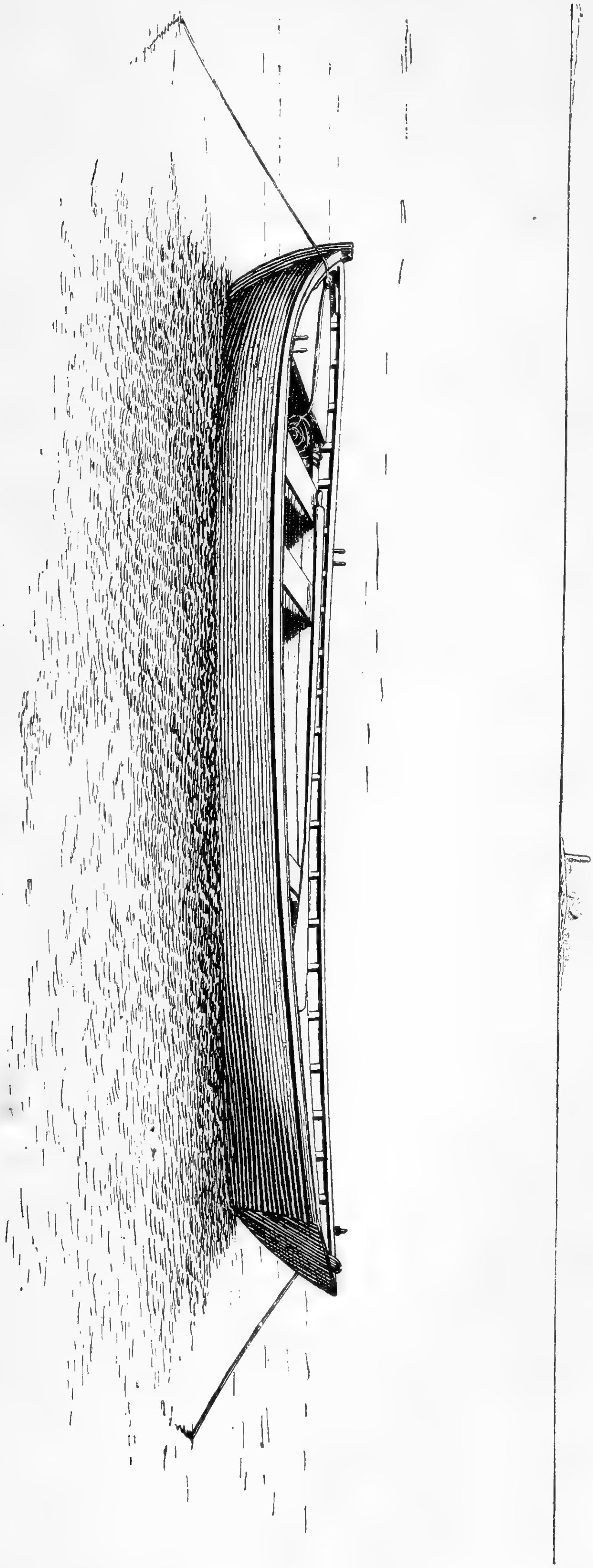
The sails are cotton duck, of American manufacture. The mainsail, foresail, and forestay-sail are No. 2 canvas, but the other sails are made of lighter material.

The principal dimensions are as follows:

	Ft.	In.
Length:		
Over all	64	4
On keel	59	0
Beam, extreme	20	0
Width of stern	16	0
Depth of hold	8	0
Draught of water:		
Light, aft	7	0
Light, forward	3	6
Loaded, aft	11	0
Loaded, forward	5	8
Tonnage	61 tons.	

(2) *Seine-boat.*—The boats used at Newfoundland for seining cod, herring, and capelin are essentially of one class. There are variations, due to local ideas or other causes, but so far as our observation extends the following description of a St. John's seine-boat will apply equally well to craft used for a similar purpose at Fortune Bay, Conception Bay, and along the coast from St. John's to Cape Ray.

The St. John's seine-boat has a round moderately sharp bow, a raking curved stem, round easy bilge, long convex floor, short run, and a wide V-shaped square stern. It is a keel craft, and heavily built. It has only a moderate sheer. Inside, at the bow, there is a platform on a level with the thwarts; which is about 5 feet long fore and aft. Aft of this, in the body of the boat, are three thwarts for the six rowers, who sit "double-banked," two on each thwart. This part of the boat is ceiled. In the after part of the boat are two other thwarts, the aftermost one being 4 feet from the stern. Between these thwarts, on a platform, is stowed the seine, and at the extreme stern is a smaller platform for the steersman to stand on; this is about 3 inches higher than the other. Here also, in the bottom of the boat, is sometimes



SEINE-BOAT. (See page [42].)

Drawn by E. I. Rogers.

placed a glass light, for the purpose of seeing schools of fish the boat may be passing over. This is, however, as in this case, frequently omitted, the water-glass being used instead whenever the surface water may be agitated by the wind. The skipper often stands at the bow, and his experience enables him to detect the presence of fish by indications which would escape the notice of any but those trained to this work.

The thwarts are made of 1½-inch thick spruce plank, and are strongly kneed. A stout piece of hardwood plank, about 10 inches wide, is nailed to the inside of the stern, above which it rises a few inches. The top end of this is scored or scooped out like a boom-crutch, and this serves for a scull-hole or for holding the steering oar.

The boat is propelled wholly by six roughly-made spruce oars, each with a peg near its handle. These oars are 22 feet long. A similar oar is used by the "boss of the gang" to steer with. Boats of this class are generally built in a rude manner, very little care being expended in elaboration of finish. They are sometimes painted, but are more commonly heavily coated with coal-tar. The sole objects are to get a boat that will be adapted to the work, will stand rough usage and which can be built for the least possible expense. Wooden tholes are used, two for each oar, and these are usually made of spruce branches, which are tough and not easily worn out.

The following are the details of the material used in building a boat of this kind. The frames, twenty-seven in number, are of birch and spruce 2 by 2 inches, or 2 by 1¾ inches; plank of pine, 1 inch thick; gunwales of birch, 3 to 5 inches wide, three-quarters of an inch thick; black wrought-iron nails are used for fastening.

The dimensions are as follows:

	Ft.	In.
Length, over all	31	6
Beam	7	7
Depth, gunwale to top of garboard ceiling	2	3
Width of stern	5	9
Depth of stern	2	1
Distance between after thwarts	6	3

A boat of this size and class is manned by seven men, one (the skipper) to look for fish and six to row. When setting the seine only four men row, two throw the seine, and the skipper steers the boat.

A cod seine, of the kind used by such a crew, is 130 fathoms long, 76 feet deep in the bunt, and 61 feet deep in the "bridles," or at the ends. The size of the mesh varies from 3½ inches (stretch measure) in the bunt to 4 inches on the arms and 5 inches near and at the ends. Sometimes the catch is taken in the seine boat, which will carry enough green fish to make 15 quintals of dry cod.

(3) *St. John's Trap-Boat.*—A peculiar style of boat is used at St. John's and vicinity for hauling the cod traps set along the coast, and because of its special work is locally called a "trap boat." One of

these which was examined was a carvel-built keel craft, entirely open, with a medium sheer, sharp bow, slightly concave water-line forward, a raking, curved stem, considerable rise to floor, a round side, rather long run, and raking, heart-shaped, square stern, in which was a large scull-hole. This boat had five thwarts, the after one being adjustable and the forward one forming a part of the bow platform, or, in other words, the after end of the platform rests upon it. There is a wide seat across the stern, and one on each side extending from the after thwart to the stern seat. The boat is ceiled amidships up to within 10 inches of the thwarts on either side; and there is a platform forward and another aft.

Boats of this type are generally propelled with large spruce oars; sails are not much used.

The material used in construction is the same as that employed in building the seine boat.

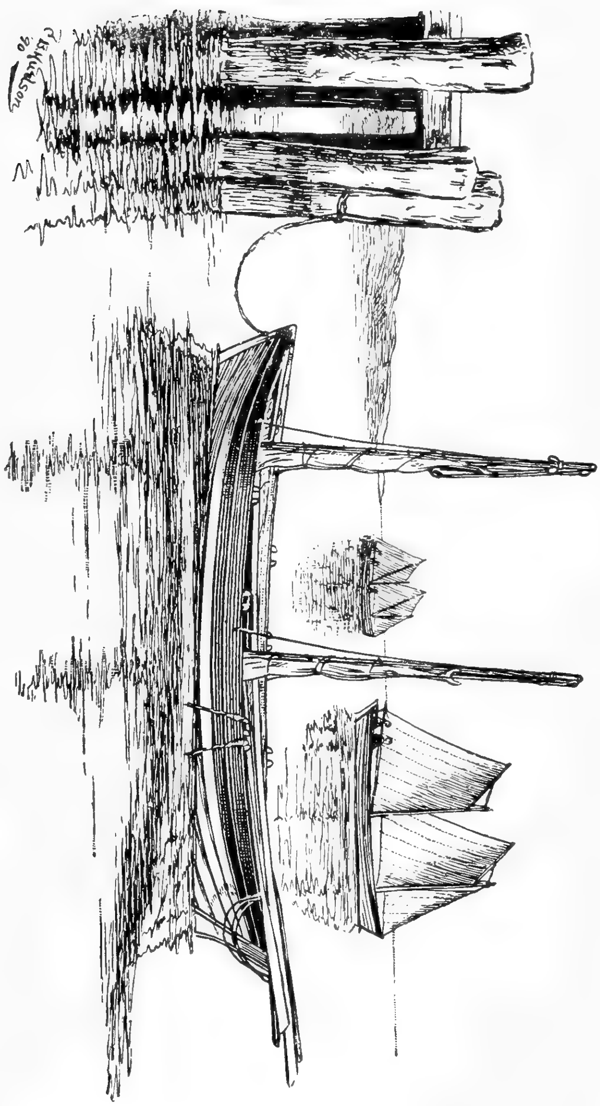
The following are the principal dimensions of the trap boat above described:

	Ft.	In.
Length, over all	27	9
Beam	6	4
Depth, ceiling to top of gunwale	2	5

(4) *Newfoundland Pinkie Boats.*—Sharp-sterned, clinker-built, keel boats—often called "whale-boats"—in form resembling those of the New England coast, are used to a considerable extent in the fisheries of Newfoundland. These boats are usually entirely open, with curved stem, straight stern-post, sharp bow, concave water-lines, round bilge, clean run, and rudder hung outside. They are commonly schooner-rigged, carrying two gaff-sails, and often a jib. They are excellent sea boats, sail well, and row easily.

The following notes on this type of Newfoundland fishing boat have been obtained by the writer from a study of the small craft on the south and east coasts of that island.

A favorite type of fishing boat in use at St. John's, and also on other parts of the Newfoundland coast, is of New England origin. There is more or less variation in the shape of these, corresponding to the differences between the so-called "Hampton boat" of Massachusetts and the "pinkie boat" of Maine. The latter, however, is most generally preferred, being considered the ablest in heavy winds and safest in a rough sea. We were told in all candor by a fisherman of St. John's that these boats had frequently beat to windward in an off-shore gale and entered harbor when decked vessels of 30 to 70 tons could not make any way against the wind. This might seem incredible were it not vouched for by similar statements from fishermen in other localities. Many if not most of these boats have been built in New England. They are strongly constructed, of pine plank and juniper frame, and are copper fastened; consequently they wear well with good usage, and it is not uncommon to find one twenty years old or more. One was pointed



PINKIE BOATS. (See page [44].)
Drawn by C. B. Hudson.

out to us that was about forty years old—"built before the fire in '46," the owner told us—though it had been partly rebuilt. The model and style of construction has, however, been imitated very closely by the native fishermen, who, having found a boat excellently well adapted to their wants, have had the good sense to adopt it.

The following is a description of a Newfoundland-built boat of this kind which we saw at St. John's, and which forms the subject of the illustration:

It is a clinker-built keel craft, with a rising floor, round easy bilge, side flaring slightly above water, sharp bow and stern, the former somewhat the fullest, and having convex lines above and moderately concave lines at and below the load-water line. The stem and stern-post both have a strong rake, the former being curved and the latter straight. It has a strong sheer and a rather low freeboard amidships. On top of the gunwale, however, is firmly and permanently secured a water-tight wash-streak—locally called "wash-board"—that extends from stem to stern, being 8 inches high in the middle and 5 to 6 inches high at the ends. This, of course, adds materially to the freeboard, and makes the boat correspondingly dry and safe in a sea-way. A similar wash-board is used on the Block Island boats, though it is adjustable, and does not extend quite to the stem and stern.

The interior is divided as follows: At the bow is a sort of cuddy, 3 feet 10 inches long fore and aft. This is decked, and has a bulk-head on the after side, in which is a door. This cuddy is used for general storage purposes; the foremast steps in the after part of it. Aft of the cuddy is a standing-room, platformed at the bottom, 2 feet long fore and aft, and extending from side to side of the boat. In this one man stands to fish. Immediately abaft the standing-room is the forward fish-pen, locally called "fish-room." This is 4 feet 6 inches long fore and aft, and is covered by boards loosely laid on top from one thwart to the other. The space immediately around and just forward of the mainmast holds the stone ballast, and over this is a platform a few inches below the level of the thwarts, leaving an open space or standing room forward of the mast about 15 inches fore and aft, and, like all the other divisions, extending from one side of the boat to the other. In this one man stands to fish when 3 men are carried, which is often the case on boats of this type. The after fish-room is situated aft of the mainmast, and is 2 feet 6 inches long. The after cuddy, at the extreme stern, is about 4 feet long. In this are stowed food and fishing gear. In front of this, extending from side to side, is a seat, about 9 inches wide, for the steersman to sit on. Between the after fish-room and the stern cuddy is a standing-room 2 feet 6 inches long, in which the skipper stands to fish. This is platformed, and beneath it is the bailing well, access to which is had through a small trap-door in the platform. Each boat is provided with two or more adjustable stools for the oarsmen to sit on whenever it is necessary to row. These stools

are made by nailing together at right angles two pieces of board about 7 or 8 inches wide and 12 to 18 inches long, these being stayed or strengthened by narrow pieces fastened diagonally across the angle. One end of this rude contrivance rests on a cleat nailed to the boat's side, and the other on top of one of the thwarts, or the boards which cover the "fish-room." These boats are ceiled to the thwarts.

Boats of this class are schooner-rigged, and generally carry a "lug-footed" gaff foresail and mainsail, and a small jib. A few boats, however, have sprit-sails. The spread of canvas is small, for several reasons; first, the land is high and steep, and squalls are frequent when the wind blows from the hills; second, the nearness of the fishing grounds to the "stages" renders it unnecessary to have large sails; and, third, the fishermen are generally poor, and can not afford any expense that is not actually required.

The sails are usually made of hemp canvas or cotton drilling, and invariably have some preservative applied to them. They are most commonly daubed over with cod-fish oil or the cheaper blubber, and with this is often mixed coal tar; sometimes the sails are tanned. Tanning makes the sails a reddish brown, but the oil and tar stains them a dirty black. There are two outriggers aft, to which the mainsheet trims, one of these projecting from each quarter a little abaft the rudder. The sails are commonly attached to the masts by wooden hoops—sometimes by ropes—and may be hoisted or lowered, but they are generally furled on the mast. Three or more long roughly-made spruce oars, and one or two shorter ones, are carried for use in calm weather. They have a peg in the butt of the handle—a characteristic feature of Newfoundland oars. A five-pronged iron anchor of about 25 pounds' weight is used. This is attached to a coir rope-cable, the end of the rope being made fast to a piece of chain 7 fathoms long, that in turn is secured to the crown of the anchor, while a few turns of line hold it to the anchor ring. If caught in the rocky bottom the line breaks, and the anchor may be pulled up by its crown. Coir rope is used for painter, cable, etc., because it is cheaper than manilla or hemp, and also more elastic than either.

The material used in construction is generally as follows: American pine, three-fourths inch thick, for outside planking and ceiling; oak or juniper for frames, gunwales, etc.; spruce for thwarts, and copper for fastening.

A boat will cost from $85 to $100 ready for use, but this is usually exclusive of more or less work done by the fishermen, who ballast their craft with stones, and generally make the oars, masts, etc., even if they hire the hull built.

The following are the dimensions:

	Ft.	In.
Length, over all	25	0
Keel	20	0
Beam	7	4½

	Ft.	In.
Depth, top of upper strake to ceiling	3	5½
Top strake, depth	0	8
Outriggers for mainsheet, each	2	5
Mainmast, total length	21	0
Foremast	23	0
Fore and main gaff, each	7	2
Bowsprit, outside	3	0
Oars, three	24	0
Oars, two	13	6
Area of canvas (22 inch duck)	45 yards	

These boats have two or three men in a crew. They are usually painted outside and in, white, with black top streaks being the most favorite colors above water; the bottom is coated with metallic paint.

They can carry 12 quintals of fish, besides about 1 ton of ballast, fishing gear, etc.

(5) *Newfoundland fishing skiff.*—A clumsy, clinker-built, keel boat, locally known as a "skiff," broad and moderately deep, with square stern and rather full rounding bow, is more exclusively used in the Newfoundland inshore fisheries than any other. These vary from about 15 to 30 feet in length and from 5 to 8 feet in width. The smaller ones are generally propelled with oars, assisted by a single sprit-sail, but the larger ones usually have two small sprit-sails and a jib, and occasionally a "jigger" sail at the stern. The seine boats used for shooting cod and herring seines are a modification of the skiff, being somewhat longer in proportion and very broad aft, though it should be said that ordinary skiffs are extensively employed for setting seines. Some of the boats intended especially for cod seining, and perhaps some of those which are used for catching herring, have a piece of glass fitted in the bottom near the stern, just beneath the steerman's feet, this glass enabling the skipper or seine-master to see the fish some distance beneath the surface of the water as the boat is rowed along by its crew. Others use the "fish-spyer," a metal tube with glass bottom.

At St. John's, and elsewhere in many of the adjacent harbors along the coast, one type of square-stern fishing "skiffs" is in very general use. There are certain differences in size, etc., but boats of this class are generally very uniform in shape. They resemble in form the boats used on the sealing ships, and are commonly called "sealing-punts," though they may never have been used for catching seals. In the localities where the fishermen seldom engage in the seal fisheries, as, for instance, the harbors in Fortune Bay, a craft of this class is simply called a "punt" or a "skiff." Many of those used in the localities last mentioned are larger than the St. John's boats of the same type, and frequently have a somewhat different rig. The most noticeable, and perhaps the most common, difference in the rig is a small sprit-sail carried at the extreme stern, the mast being stepped as far aft as possible, and the sheet of the sail trimming to the end of an outrigger or to the weather quarter. This sail is called a "driver" or "jigger," and has

probably been introduced by former residents of the Channel Islands—Jersey and Guernsey—who, coming here to fish, have brought with them the ideas of rig they have formerly been most accustomed to.

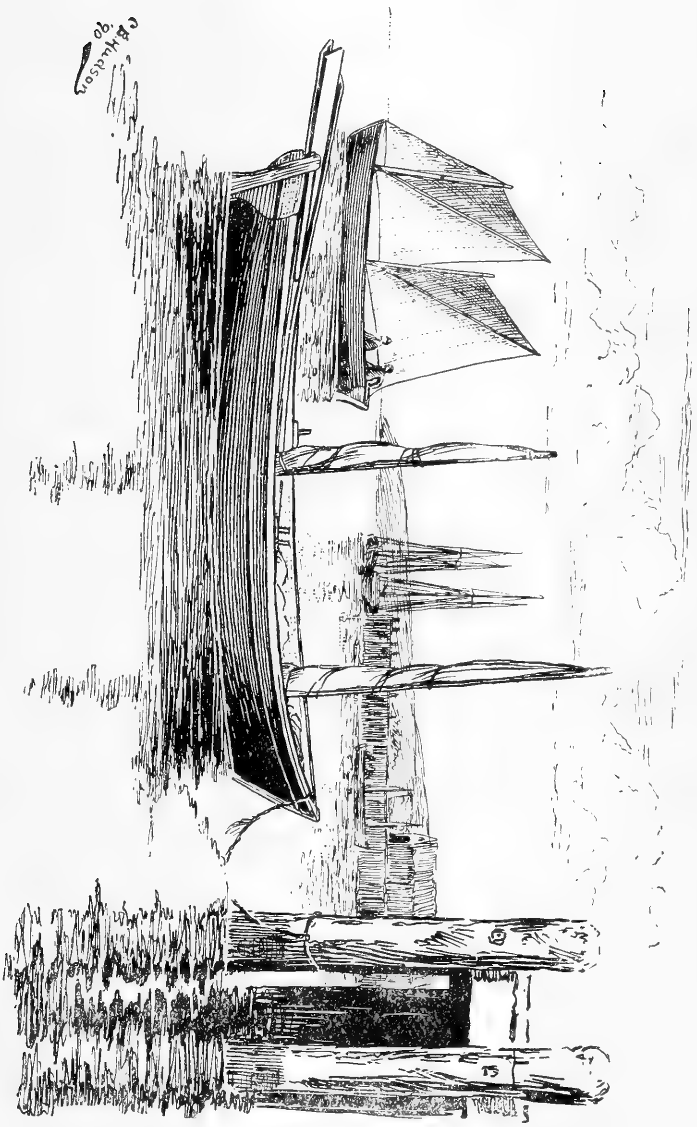
The following are the details of a St. John's boat of this type (see plate X), which may be taken as a fair representative of the class to which she belongs: This is a carvel-built keel boat, open, with a moderate sheer, sharp bow, raking curved stern, considerable rise to floor, round easy bilge, side flaring slightly above water, a good run, no overhang to counters, and a heart shaped, raking, square stern, with rudder hung outside. She is rather roughly built, of spruce chiefly, has 19 sets of timbers, $1\frac{1}{2}$ by $1\frac{1}{2}$ inches, and is fastened with black wrought-iron nails. Like the so-called "Yankee boat," this also has a wash-strake, above the gunwale, which is 6 inches high in the middle. Inside of the upper edge of this are fastened 3 large, clumsily made spruce rowlocks (each 18 inches long, 4 inches deep, $1\frac{3}{4}$ inches thick in the middle, and chamfered at ends), and into these are shipped square-cornered rowlocks, shaped something like the figure 4. This style of rowlock seems to be preferred by the St. John's fishermen, for I noticed that it was almost exclusively used, except, perhaps, on the seine or trap boats. The "scull-hole" in this boat is unique, being simply two round wooden tholes stuck in the stern, on the port side, so as to steady the oar.

The interior of the boat is divided into standing rooms, fish rooms, and lockers, on the same general plan as on the larger sharp-sterned craft. Aft is a locker 4 feet 3 inches long, covered with loose boards 6 or 7 inches below the top of the wash-strake, or just beneath the gunwale. Forward of this is the after standing room, 15 inches fore and aft, next the fish room, which is loosely covered with boards laid from one thwart to another. In this is stowed the stone ballast, around the mainmast, which is stepped in the thwart at its forward end. A second standing room, 14 inches fore and aft, is immediately forward of the mainmast; then comes a fish room (3 feet 6 inches), and next the forward standing room (17 inches). There is a cuddy at the bow, with a fixed deck and bulk-head; a door or hole in the latter serves as an entrance, and the foremast is stepped close to the after end of the cuddy, which is 3 feet 6 inches long. In this are stowed lines, food, etc.

Two small sprit-sails and a diminutive jib are carried, the latter tacking down to the stem head. The sails are coated with a mixture of coal-tar and cod oil, and no booms are used; the single part of the mainsheet reeves through a thimble, one of which is secured to either side of the stern by a rope becket. The anchor and anchor-line are the same as those in the larger sharp-sterned boats, though possibly a little smaller; and the oars differ only in size.

The following are the principal dimensions:

	Ft.	In.
Length, over all	19	0
Beam, extreme	5	0
Width of stern	3	2



FISHING-SKIFFS. (See page [47].)

Drawn by C. B. Hudson.

	Ft.	In.
Depth, top of wash-strake to keelson	2	3½
Length of foremast, above thwarts	9	6
Mainmast above thwart	7	9
Oars, 2	17	6
Oar, 1	14	0
Tiller	4	3

A boat of this kind costs from $20 to $25 as a rule, but is often built by the fishermen at a less expense. They do not, however, last nearly so long as the "Yankee-built" boats, and, though available to a poor fisherman who could not afford the more expensive craft, they are, nevertheless, not so cheap in the end. They are manned by two or three persons, one of whom is often a lad of twelve to sixteen years, and they are employed chiefly in the shore cod-fisheries, though occasionally they may engage in the capture of squid, herring, or other species which frequent the coast. These boats are usually coated with coal-tar. They are built "by the eye," as, indeed, are nearly all of the Newfoundland fishing boats. No model or lines are used; the keel, stem, stern-post, and stern are laid down, two or three frames erected, and battens nailed to these; the other frames are made to correspond more or less closely to the shape of the battens. After these are set up the boat is planked. Necessity inspires ingenuity, and here, as elsewhere, the fisherman must build his boat in most cases, or go without one, the consequence being that he soon acquires sufficient skill for this purpose, and, if he have a natural aptitude for such work, he may produce excellent craft, and ultimately acquire local renown and something more than the rudiments of a boat-builder's trade.

(6) *Toulinguet fishing boats.*—Toulinguet is the most northern village of any importance on the east coast of Newfoundland, and, like all other towns of that province, depends solely on the fisheries. In the spring the inhabitants engage in the seal fishery, going out in small, lightly built boats upon the fields of ice that crowd in against the coast at this season, to hunt for herds of seals, which are often found on the ice packs. In summer the cod-fishery occupies the attention of the fishermen.

But the boats which are used for hunting the seal are also employed in the cod-fishery. Certain qualities are required in a sealing skiff, which must be dragged for miles over the ice, and, since the light, strong, swift boat needed by the sealer is also well adapted to the cod-fishery of this locality, it is not surprising to find that larger craft, built especially for cod-fishing, have the same form of hull and style of construction as the skiffs that are built for seal-hunting.

Therefore the boats used at Toulinguet are of one type, a highly specialized form of sealing punt, resembling somewhat the punts carried on the sealing vessels sailing from St. John's, but much more symmetrical than the latter and constructed in a superior manner.

In building these boats for the seal fishery the special object sought

is to make them adapted to use on the ice. The lighter they are the easier they can be moved, and they require much strength and elasticity to withstand the rough usage they must get, while the curved and sloping stem and stern-post and the smooth planking facilitate their passage over ice-floes.

The difference in the size of the boats at Toulinguet depends chiefly on the work they have to do. Those employed in the trap and seine cod-fishery are the largest, and average 28 feet in length over all; the hand-line boats range from 18 to 20 feet over all, while the sealing-punt (which is also used for line cod-fishing) averages about 16 feet in length.

As a rule, the boats of all sizes are provided with sails and oars. The rig varies a good deal, however, and apparently depends entirely upon the fancy of the boatmen. Some of the boats are sloop-rigged, with the mast a little forward of amidships; they carry a loose-footed sprit mainsail and jib, the latter tacking down to the stem-head (see plate VII). The schooner-rig is in favor. Sometimes only two sprit-sails are carried, but perhaps as often a boat will have three sails, a small jib being set on a short bowsprit. Some boats are also rigged as yawls, with the mainmast short and well forward, a small jib, and a diminutive sprit and boom jigger-sail (or "driver") set on a little mast which is stepped at the extreme stern.

The following are the details of construction, etc., of one of the Toulinguet boats used for cod-fishing (see plates VII and XI for lines and sail plan):

She was a carvel-built, open, keel boat, with sharp bow, raking curved stem, rising floor and flaring sides, long easy run, heart-shaped, raking square stern, and no overhang to counter. She had three thwarts and a seat across the stern. These were 6 inches below the gunwale and rested upon a ribband $1\frac{1}{2}$ by $\frac{1}{2}$ inches, which extended from stem to stern of the boat. She had two sets of oak rowlocks, each having a single thole-pin in its after end.* There was a small platform aft, a keelson piece (or foot-rest) 3 inches wide, three battens or ribbands on each side, each 2 inches wide and separated about their width from each other. There were twenty-one frames, spaced 9 inches from center to center. The keel was shod with iron to facilitate its passage over the ice, and also to protect it from injury.

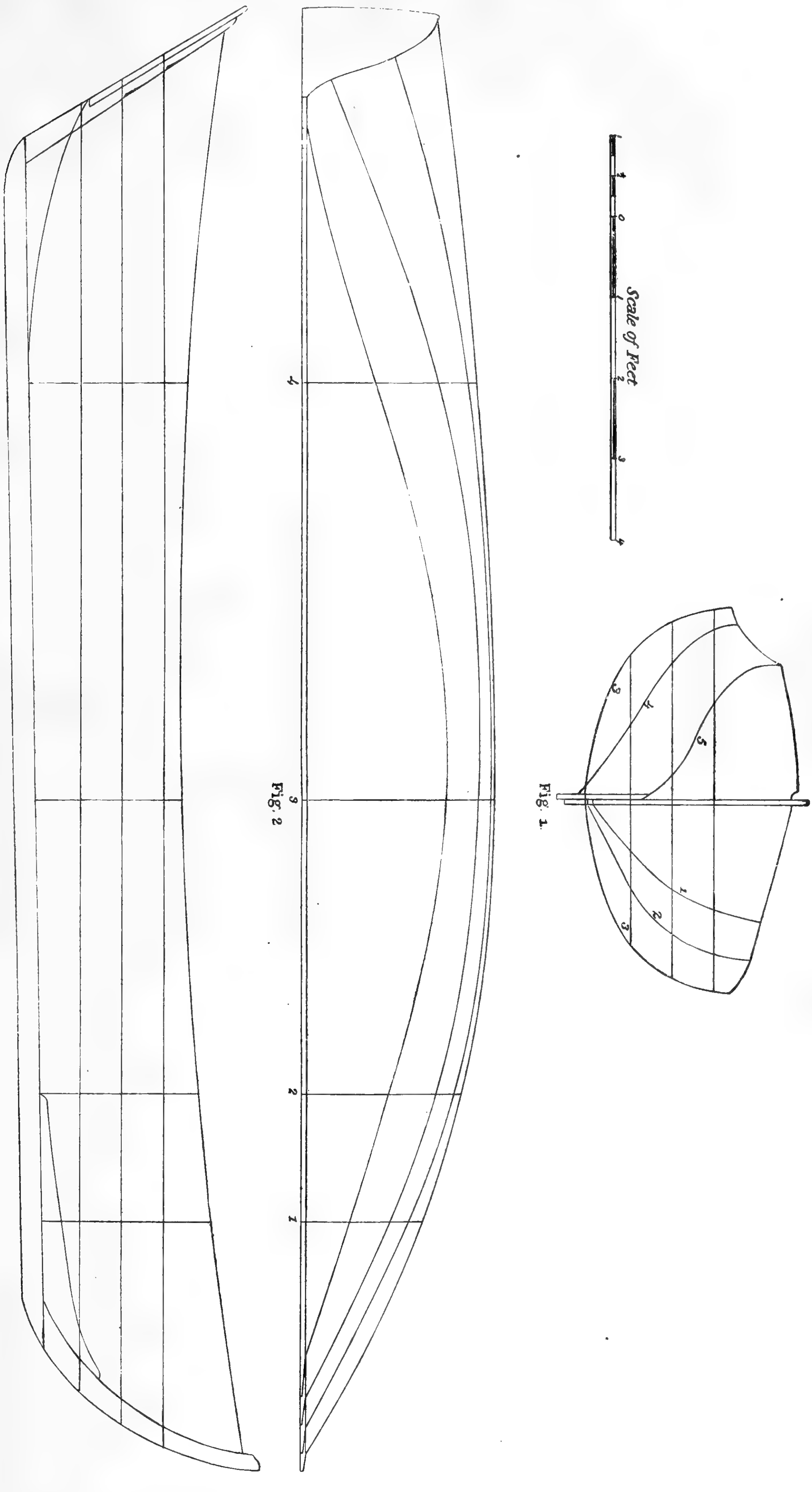
The material used in construction is as follows: Timbers, keel, stem, stern-post, gunwales, and thwarts of spruce; planking of pine; fastenings of black wrought iron.

Dimensions.

	Ft.	In.
Length, over all	17	$9\frac{3}{4}$
Keel	14	6
Beam	4	9
Moulded depth, amidships	1	10
Width of stern	3	3

* The rowlocks are commonly made of birch. But occasionally the staves of an oak cask are used, as was the case when the boat above described was built.

PLATE XI.



TOULINGUET FISHING-BOAT. (See page [49].)

FIG. 1. Body plan.

FIG. 2. Half-breadth plan.

FIG. 3. Sheer plan.

Drawn by J. W. Collins.

	Ft.	In.
Width of stern-seat	0	8
Width of thwarts	0	7
Gunwales	2 in. by 1¾ in.	
Timbers	⅝ in. by ¾ in.	
Plank *	½ in. thick	
Length of thole-pins	9 inches	
Length of oars, each	8 to 9 feet	

The oars are made of spruce, of the ordinary pattern. They are each provided with a grommet strap to hold them to the thole-pins. These straps are made by twisting together flexible spruce withes. In the loom of each oar, about 15 inches from the end of the handle, is a stout wooden peg with projecting ends, its purpose being to prevent the beckets slipping off the oar.

The Toulinguet fishermen say that it is essential to their success in the seal fishery that a boat should be propelled as quietly as possible. Oars fitted with beckets can be used with very little noise, and the seals can be approached when the clanking of the oars in the ordinary rowlocks would frighten the animals and render their capture impracticable.

(7) *Boats of Fogo Island, Newfoundland.*—At Seldom-come-by Harbor, on the southern side of Fogo Island, a style of fishing-boat is used that differs in model and rig from any other boat I have seen on the Newfoundland coast. It is an open, carvel-built, keel craft, deep and rather beamy, with sharp bow, rising floor, slight flare to top side, a rather fine run, and square stern. Some have a little overhang to their counter, but, as a rule, there is no overhang, and the rudder is hung outside.

There is a moderate rake to the stern-post and stem, and the latter often has a reflex curve like the stem of an American clipper schooner.

These boats are usually built of spruce or juniper; the planking is seven-eighths of an inch thick; they vary from 18 to 28 feet in length and from 6 to 8½ feet beam.

With few exceptions the boats are sloop-rigged, the mainmast being stepped amidships and the jib-stay set up at the stem-head. In some cases a bowsprit, a foot or two in length, is used. Occasionally, also, a small mast is stepped at the extreme stern and a diminutive spritsail is carried on it, the sheet trimming to an outrigger which projects from the stern. The mainsail is generally a boom-and-gaff-sail, but sometimes a sprit is used instead of a gaff on the smaller boats.

(8) *Labrador Fishing-boats.*—The boats employed in the Labrador fisheries are similar to those of Newfoundland or Nova Scotia. A sharp-sterned boat, usually called a "barge," is the same as that used at St. John's, and originated in the United States. The other most common form of fishing-boat has been introduced by the fisher-

* The planks, of which there are six strakes on each side, are three-fourths inch thick in the rough, as obtained by the builder, who planes them to one-half inch.

men of Nova Scotia who visit the Labrador coast in summer in pursuit of cod and herring. This, because of its origin, is called a "novie" or "nova"—a name that not only defines the type of boat, but designates the country from which it was first taken to Labrador.

Mr. Stearns, in writing of the Labrador fisheries, makes the following remarks concerning the boats employed in that region:

"The boats used in the ordinary fishing are of two kinds: Those called "novies," or Nova Scotia boats, being long and narrow, shallow, and carrying no ballast, which, should she overturn, it would be impossible to sink her, since she would immediately right again even if full of water; and those called "Yankee barges," or boats brought here from the States or made here, but to a similar pattern. These are very wide for their length, and correspondingly deep. With the barges the seats are so arranged that they form five partitions. The center one is heavily ballasted with rocks. Of course, should one of these boats be upset or filled with water, it would immediately sink to the bottom. Strange to say, the barges are in more demand than the novies, from the fact that while the former hold 8 quintals of fish freshly caught, the latter hold only 4, or one-half the quantity. The men choose to risk their lives rather than lose their fish, and principally for this reason, that when the fish bite well they can load their boat without stopping to run several miles home in a calm, pulling at the oars all the way, to unload and return, often to find the fish gone or darkness approaching."*

(r) *Apparatus.*

(9) *In general.*—Trawl-lines are used almost exclusively, if not entirely, by the bank fishermen. Both hand-lines and seines are employed on the Labrador coast. Hand-lines, trawl-lines ("bultows" or "boulters" in the local vernacular), gill-nets, seines, and traps are operated in the coast fisheries.

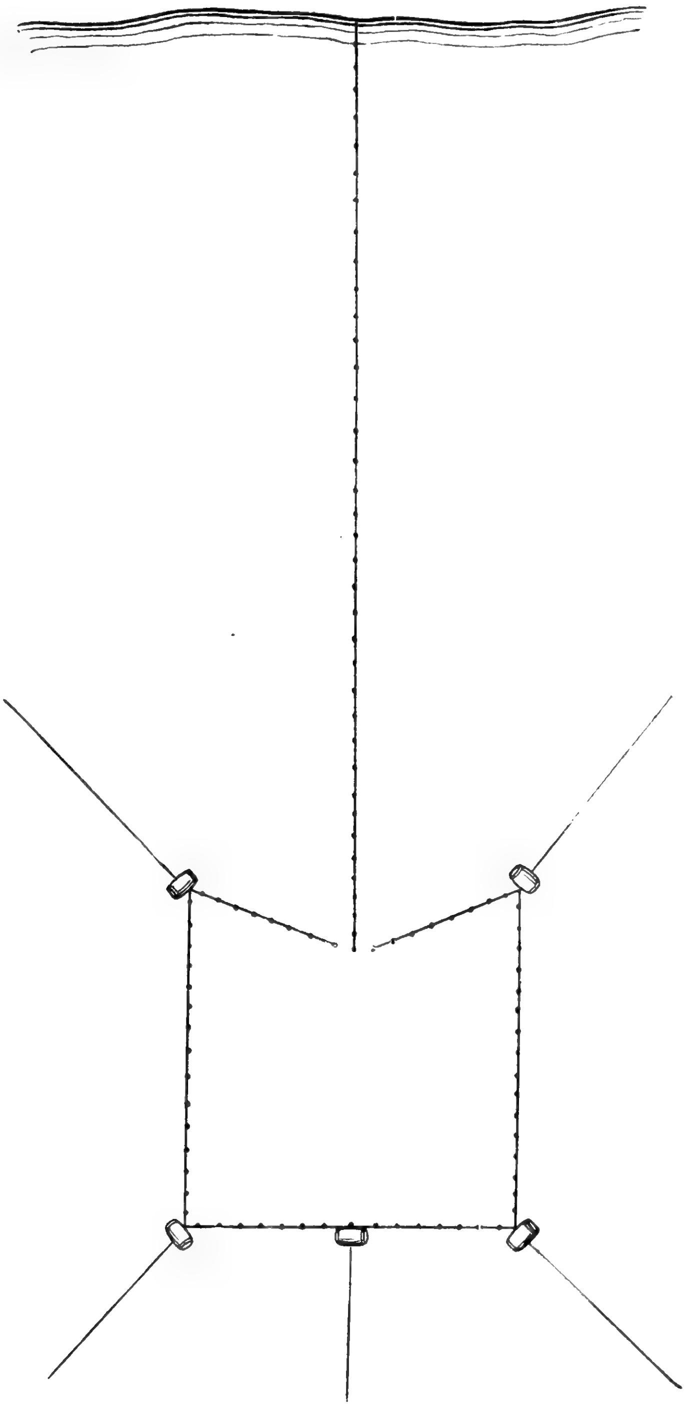
(10) *Trawls and hand-lines.*—The trawl-lines are essentially the same as those used by the New England fishermen. The hand-lines are usually rigged with a rough, home-made sinker or "lead," to which are attached the snoods and hooks. When the cod school at and near the surface, as they generally do when capelin are on the coast, so-called "float-lines" are used, these being rigged by simply fastening a hook to the end of each line.

(11) *Gill-nets.*—Gill-nets are set at the surface when cod are schooling, but at other times are moored close to the bottom.

(12) *Haul-seines.*—Haul-seines are still extensively used. These vary considerably in dimensions.

(13) *Cod-traps.*—In recent years traps have been introduced, and in many places have been very effective in taking cod. The statement is

* "The Labrador Fisheries," by W. A. Stearns. Bulletin of the U. S. Fish Commission, Vol. V, p. 8.



PLAN OF COD-TRAP. (See page [52].)

Drawn by J. W. Collins.

made, however, that in localities where traps have been used for two or three years the results obtained are far below what they were when this form of apparatus was first set. Mr. James Vinecomb, of St. John's, told me that he believed no traps would be used in six or seven years.

The Newfoundland cod-trap (see plate XII) is very simple in its construction. The trap or "crib" is box-shaped, nearly square in plan, of a depth suitable to the locality, and set floating, with corks along the upper edge, buoys at the angles, and a buoy at the middle of the "back," or side farthest from the shore, to support the top of the trap where the mooring lines are fastened. The trap is held in place by an anchor, or "killick," attached to each corner and the center of the back by lines that vary in length according to the depth of water. The leader extends from the mouth of the trap to the shore, its length being governed entirely by local conditions.

The diameter of an average cod-trap varies from 40 to 50 feet, and the width of the entrance or "mouth" on each side of the leader is 5 feet.

(s) *Methods of Fishing.*

(14) *General Observations.*—In the bank cod-fisheries the American dory is used and the same methods are employed as are in favor among the New England fishermen. It is chiefly in the shore fishing that these methods are in any manner peculiar to Newfoundland, and these vary considerably in different parts of the island. It will be practicable here to consider only those most commonly employed.

(15) *Trawl-line fishing.*—On some parts of the island trawl-lines are set at the surface for cod when capelin are on the coast, the lines so set being called "floating bultows" or "boulters." The lines are set so that the hooks attached to them will be about 7 or 8 feet from the surface of the water. A "mooring," grapnel or anchor, is put out with a buoy-line attached. The end of the ground-line of the bultow is then bent around the buoy-line in such a way that it will easily slide up and down upon the latter. A short piece of line 6 or 8 feet long is made fast to the buoy and its other end is bent to the ground-line so that the latter shall not go below a certain depth. The ground-line with the hooks attached is then payed out and its last end is made fast to a mooring in the same manner as the first. If necessary, additional floats or buoys are attached to the lines at suitable intervals. This method of fishing is adopted because the cod generally school "up in the water" when they are chasing capelin. As soon as capelin leave the coast the cod no longer rise so near the surface and the trawl-lines must be set near the bottom.

(16) *Hand-line fishing.*—In hand-line fishing at the bottom, the boats are usually anchored and the lines are put out on each side. The crew varies from one to three, or more. At St. John's two men and a boy usually go in one of the "pinkie" boats. When there are three in a

crew, one (the skipper) stands aft and uses three lines, the boy amidships has two lines and the other man at the bow three lines.

The lines are "tried" by pulling in a few feet very often, the fisherman thus determining whether a fish is on or not. If so, he pulls in the line, unhooks the fish, rebaits, and throws out the gear. While the line is running out (the weight of the lead taking it to the bottom), the fisherman turns his attention to the other lines which he tries and pulls in, or waits for a bite if a fish is not on.

(17) *Float-line fishing.*—When fishing with "float-lines," a whole capelin is put on a hook which, when baited, is thrown out several fathoms from the boat. The hooks—locally called "floats"—rarely sink more than 3 or 4 feet below the surface before the fish take them.

As a rule, the boat fishermen prefer to fish during the day and return to harbor at night; but sometimes they remain out over night. In either case a rude attempt at cooking is often made, though little regard is had for neatness. The cooking consists simply of boiling potatoes and fish, and sometimes heating a pot of tea. The arrangements for building a fire and cooking are very primitive. A rude fire-place is made on the ballast amidship. Sometimes this may be only a section of huge kettle that has been broken, or a smaller superannuated pot, or, perhaps, simply a lot of beach gravel spread over the coarser boulders to prevent the fire getting through to the planking.

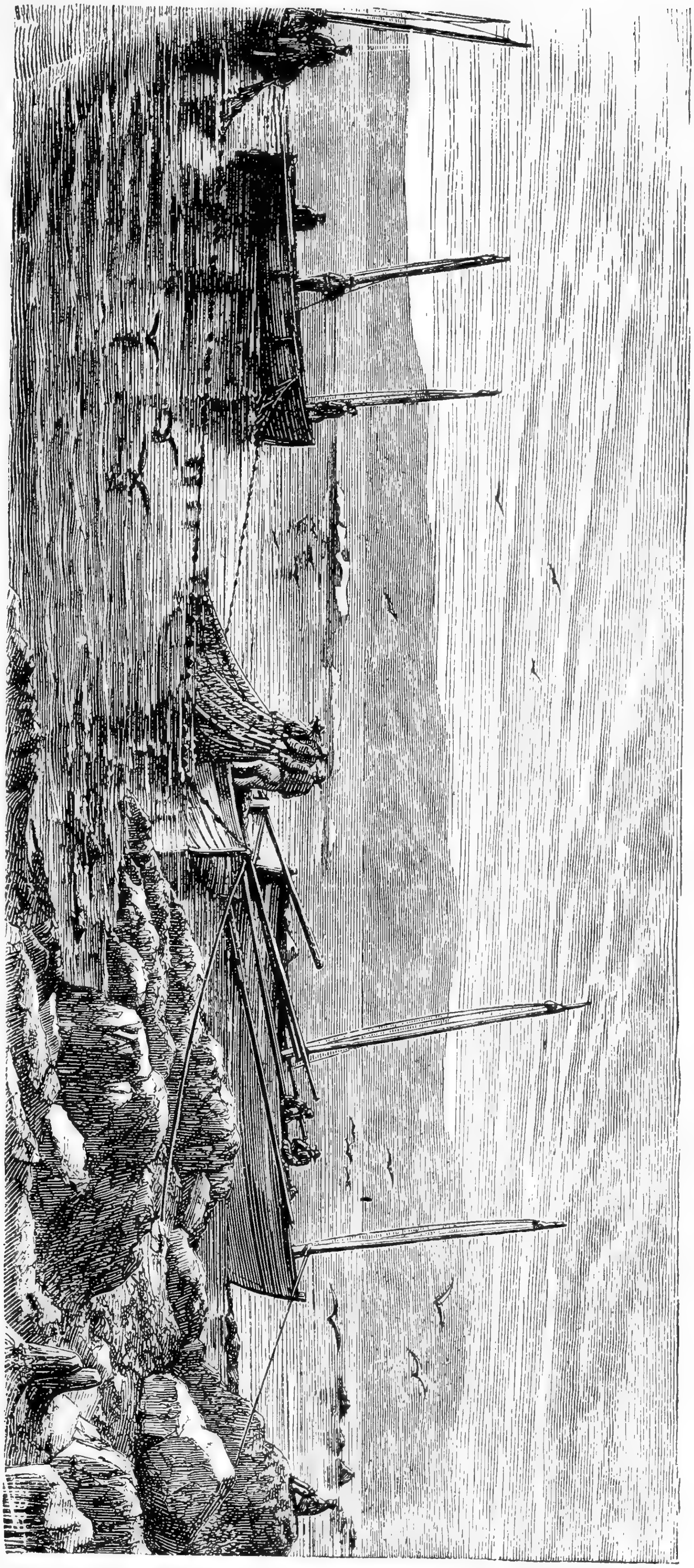
The boy builds the fire, the man forward cleans the fish that is to be cooked, and the skipper attends to the cooking. When the meal is done, the pot is taken off the fire and its contents turned out onto the rough "gang board" and eaten.

(18) *Bait.*—Herring, capelin, and squid are used for bait. Capelin are taken at Conception Bay about two weeks earlier than at St. John's. The St. John's fishermen employ boats, built especially for the purpose, to obtain bait from Conception Bay or elsewhere. Each cod boat pays a stated sum per season for bait thus secured.

In some localities it is difficult to get bait until the capelin schools come in, and recourse is had to fishing with a leaden jig cast to resemble a fish. The lines are then kept in constant motion to give the jigs the appearance of small fishes darting up and down, and also that the cod which may thus be attracted will be caught by the hooks, several of which are attached to each jig.

(19) *Gill-net fishing.*—The methods employed in the gill-net cod fishery are very simple, consisting mainly of setting the nets at night and lifting them next day.

(20) *Cod seining.*—In seining cod the boat is slowly rowed along near the shore, the skipper or seine-master watching carefully for the appearance of a school of fish by looking through a water telescope or through a glass in the boat's bottom. When fish are seen, and their course noted, one end of the seine is landed and the boat is rapidly rowed around in a semi-circle so as to inclose the fish and bring the other end



SEINING COD ON NEWFOUNDLAND COAST. (See page [54].)

of the net to the shore. As soon as the boat touches the shore all hands spring out and hastily haul in upon the ends of the seine until the fish are gathered in a compact mass in the bunt of the net. The cod are then taken out and carried to the dressing "stage" and the seine is again placed in position in the boat ready for another "shot." Occasionally a "big haul" is secured, and then the seine is "moored" to the shore until the catch can be removed, the object being to keep the fish alive in the net until they can be dressed and salted, only as many being taken out from time to time as can be handled before they begin to deteriorate.

In trap-fishing the crib or bowl is lifted in the same manner that a pound-net is handled. The fish are taken out and carried to the curing stages in boats.

(*t*) *Fish curing.*

(See plates XIV and XV.)

As a rule, much care is exercised in curing codfish in Newfoundland, due largely to the fact that the fish are culled into different grades for market, and the best cured fish demand the highest price. Special attention is paid to splitting the fish, since any neglect in this particular will injure the product. New England fishermen are often less careful about splitting cod, for the reason that the fish are not dried so hard as at Newfoundland, are less liable to be broken, and also because large quantities are made into "boneless cod," and packed into boxes before being placed on the market. The markets of the United States demand large white fish, and perhaps less is thought of the splitting, and more of washing, etc.; while in Newfoundland the conditions are reversed. A fish packer at St. John's rather tersely explained his view of it as follows:

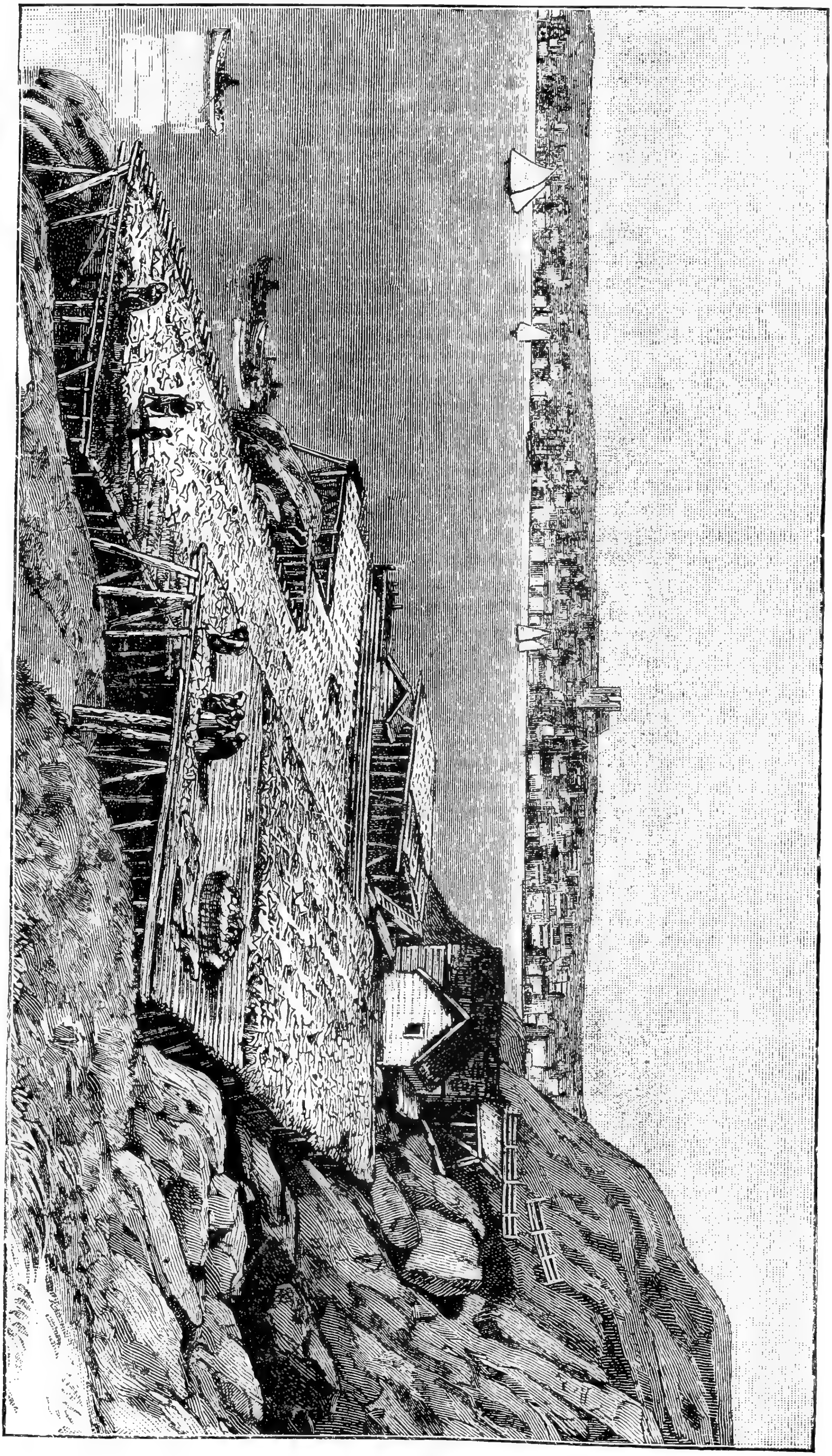
"The Americans don't take as much care in dressing their fish as we do. They think to have large fish and white ones is all that's required. We use all—large or small—and pay but little attention to beauty. The beauty of the fish is not what is most looked for here; it's the quality."

The Newfoundland cod are culled into three grades, West India, Madeira, and Merchantable; the prices for which (in 1885) were respectively 13, 17, and 20 shillings. The "merchantable fish" are usually shipped to Brazil, where they are in high favor; they are small shore cod that have been cured with special care and dried very hard. The pickle cured are generally intended for the United States. When cod are salted in casks for pickle curing, seven hogsheads of salt are put upon one hundred quintals of fish, but ten hogsheads of salt are used on the same quantity of bank cod if they are "bulked" or salted in kench. Cod that are intended for shipment to tropical or semi-tropical countries are "hard cured." They are first dried about three weeks in good weather, then stacked in piles for a greater or less length of

time (the period depending upon the condition of the weather, etc.), after which they are spread on the flakes to dry again for one or more days, when they are ready to ship.

The work of curing cod is done almost wholly by women. In many cases a women has sole charge of this work of curing the fares of bankers or vessels from the Labrador coast, and is called "master of the voyage." Being employed in curing fish from childhood, many of the women acquire great skill in this special work, and their weather wisdom, judgment regarding the proper time to spread fish, etc., are often remarkable. Married women are generally appointed "masters of the voyage," and unmarried women from fifteen to thirty years of age are employed as assistants or laborers. The girls are hired either by the season or employed in a more transient manner by the day. At St. John's the former receive about $100 or upwards for six months' labor, while the latter are generally paid 50 cents per day. If occasion calls for extra effort, and it often does, the girls are expected to work from daybreak till night, about sixteen or seventeen hours of continuous hard labor out of twenty-four. One would think this work of carrying, lifting, spreading, and piling fish would break down the health of young girls, but they seem to thrive on it, and though not remarkable, as a class, for their beauty, these "flake wallopers," as they are called, are nevertheless healthy and strong, while it is not uncommon to find those who have regular and pleasing features.

The flakes are generally built on a steep hill-side, propped up on posts, except at one side where they rest on the ground. The frame-work of the top, usually rough trunks of small trees with the bark on, is covered with boughs of the spruce and fir, and upon these the fish are spread and piled as occasion demands. Near by are the store-houses, the shanties for trying-out oil, the wharf or stage, and the other accessories of a Newfoundland curing establishment. The illustration (plate XV) shows a curing stand at St. John's. But at the out-of-the-way fishing stations along the coast the curing of cod is carried on in a very primitive manner by the fishermen, who barter their "catch" with the traders that go about from port to port in schooners to pick up all the fish they can in exchange for supplies.



CURING COD AT NEWFOUNDLAND. WOMEN AT WORK ON FLAKE-YARD AT ST. JOHN'S. (See page [55].)

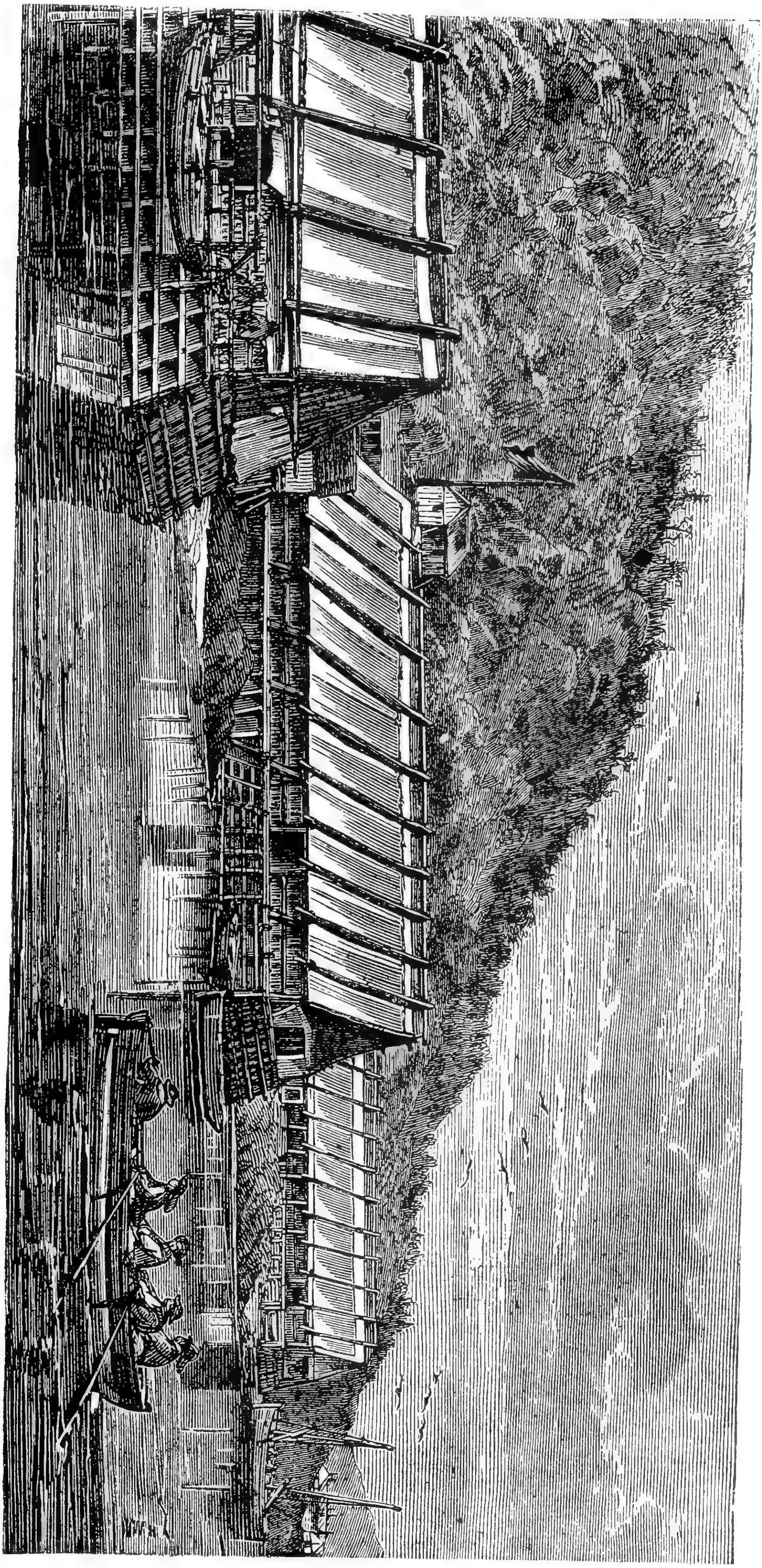
From photograph taken by N. B. Miller

11.—*Table showing air and surface-water temperatures taken on board schooner Grampus July 3 to September 1, 1887.*

Date.	Hour.		Locality.		Temperatures.		Direction of wind.
	A. M.	P. M.	Lat. N.	Long. W.	Air.	Water.	
1887.			° ′ ″	° ′ ″	°	°	
July 3	Noon		42 47 33	67 45 06	67	58	W. by S.
4	Noon		43 09 30	65 25 00	58	50	W. SW.
5	Noon		44 29 28	62 29 30	63	56	W.
6	Noon		45 19 30	60 57 00	58	51	SW.
6		3.23	45 32 00	61 14 00	60	48.5	W. SW.
6		4.40	45 36 15	61 20 00	70	54	W. SW.
7	9.00		45 36 15	61 20 00	70	55	W.
7	11.16		45 44 30	61 20 00	70	57	W. by S.
7		1.15	46 00 00	61 28 00	70	58	W.
8	1.12		47 25 00	61 34 00	58	53	NW.
8	Noon		47 25 00	61 52 30	65	51	NW.
9		1.00	47 50 00	61 52 30	56	54	N.
9		3.00	47 50 00	61 20 00	56	54	N.
9		8.00	47 50 00	61 20 00	55	54	Calm.
10	6.00		47 50 00	61 20 00	55	55.5	SE.
10		4.30	47 17 30	61 20 00	58	55	E. SE.
11	7.00		47 17 30	61 51 00	56	56	E. SE.
11	Noon		47 17 30	61 51 00	58	56	E. SE.
12	6.00		47 17 30	61 51 00	56	56	E. by S.
12		1.00	47 17 30	61 51 00	56	56	E.
13	11.30		47 19 00	61 42 00	55	55	E. SE.
13		6.00	47 14 00	61 40 00	57	56	NW. by N.
14	7.15		47 19 00	59 58 00	56	55	NW.
14	Noon		47 15 30	59 20 45	58	54	NW. by W.
15	Noon		46 20 39	55 31 00	55	52	SW.
15		3.49	46 26 00	54 52 45	54	51	SW. by S.
16	8.00		46 28 00	53 41 00	53	50.5	SW.
16	11.40		46 35 00	53 15 20	54	51	S. SW.
16		4.23	46 39 00	53 04 00	56	51	S. SW.
17	6.00		47 16 30	52 34 00	48	50	Variable.
17		1.57	47 30 00	52 34 25	55	50	SW.
17		3.00	47 34 00	52 41 00	58	50	SW.
17		6.00	47 33 30	52 42 15	63	52	W. SW.
18	7.00		47 33 30	52 42 15	58	51	W. SW.
18	Noon		47 33 30	52 42 15	60	54	S. SW.
18		3.00	47 33 30	52 42 15	60	52	S. SW.
19	8.00		St. John's Harbor		57	53	SE.
19	Noon		do		60	54	Variable.
19		4.00	do		68	53	N. NW.
20	8.00		do		57	54	SE.
20	Noon		do		58	55	E.
20		4.00	do		60	55	E.
21	10.38		47 34 00	52 41 00	60	54	SE.
21		3.40	48 09 12	52 51 00	58	52	SW. by S.
21		8.45	48 42 40	53 05 35	54	52	SW. by S.
21		10.00	48 55 30	53 16 00	55	52	SW. by S.
22		12.20	49 45 30	53 10 00	56	51	S.
22		3.00	49 45 30	53 09 00	54	50	S. by W.
22		9.00	49 45 30	53 09 00	52	50	S.
23	4.00		49 45 30	53 09 00	52	50	SW.
23	11.00		49 45 30	53 09 00	54	50	W. NW.
23		5.20	49 36 40	53 45 00	57	54	S. by W.
24	10.50		49 27 00	53 47 20	64	53	W.
24		2.00	49 27 00	53 47 20	65	54	NW.
24		8.00	49 36 05	54 12 00	62	54	Variable.
25	7.00		49 36 05	54 12 00	63	54	NW.
25	11.00		49 36 05	54 12 00	63	55	N. NW.
25		6.00	49 36 05	54 12 00	58	52	SE. by E.
26		12.30	49 42 30	54 23 30	57	56	N.
26		3.00	49 42 30	54 45 00	55	56	E. SE.
27	8.00		Twillingate Harbor		55	56	N.
27	Noon		do		60	56	Variable.
27		4.00	do		65	56	Variable.
28	4.30		49 42 00	54 47 00	56	56	SW. by W.
28	11.45		50 02 30	55 18 00	60	54	SW.
29			50 42 30	56 04 05	50	48	NE.
29			50 42 30	56 04 05	55	46	Variable.
29			50 44 40	56 05 30	58	49	SE.
29			50 44 40	56 05 30	55	49	Calm.
30	8.00		Grevigrieux Harbor		55	49	NE.
30	Noon		do		58	49	SE.
30		4.00	do		60	49	S.
31	8.00		do		52	49.5	S.
31	Noon		do		58	49.5	S. by W.
31		4.00	do		65	50	Variable.

11.—*Table showing air and surface-water temperature, etc.*—Continued.

Date.	Hour.		Locality.		Temperatures.		Direction of wind.
	A. M.	P. M.	Lat. N.	Long. W.	Air.	Water.	
1887.			° ′ ″	° ′ ″	°	°	
Aug. 1	7.00		Grevigrieux Harbor		55	52	Variable.
2	8.00		do		55	51	Variable.
2	Noon		do		57	51	Variable.
2		4.00	do		58	51	E.
3		2.30	50 55 50	55 49 00	56	51	SW.
3		9.24	51 30 40	55 19 40	49	46	SW. by S.
4			51 41 30	55 48 30	49	46	S. by W.
4			51 37 40	56 41 00	58	40	W.
5	Noon		51 37 40	56 41 00	50	39	S.
5		9.00	51 37 40	56 41 00	55	39	W.
6	6.00		51 37 40	56 41 00	55	37	W.
6		1.00	51 37 40	56 41 00	56	37	W.
7	8.00		Black Bay, Labrador		57	38	Variable.
7	Noon		do		51	39	Variable.
7		4.00	do		46	39.5	SE. by E.
8	8.13		51 22 50	57 06 30	50	55	NE.
8		5.30	50 28 30	59 11 45	47	51	N. NE.
9	6.30		49 52 00	60 21 00	56	57	W. by S.
10		7.48	50 10 12	64 00 00	52	40	Variable.
11	7.45		50 13 00	64 08 00	48	38	E. SE.
11		1.05	50 17 58	64 03 30	50	48	E. SE.
12	8.00		Mingan Harbor		53	42	E. SE.
12	Noon		do		55	48	E. SE.
12		4.00	do		53	45	E. SE.
13	8.00		do		50	46	W.
13	Noon		do		53	48	W.
13		4.00	do		55	46	W.
14	Noon		50 17 58	64 03 30	57	44	N.
15	8.00		Mingan Harbor		48	43	W.
15	Noon		do		54	44	W. NW.
15		4.00	do		55	44	NW.
16	10.00		50 13 30	64 13 30	50	42	NW.
17	8.00		Mingan Harbor		50	42	N.
17	Noon		do		48	42	W. NW.
17		4.00	do		49	42	W. by N.
18	8.00		do		48	42	E. by S.
18	Noon		do		55	45	E. SE.
18		4.00	do		61	46	S. by E.
19	8.00		do		55	42	E.
19	Noon		do		50	42	E.
19		4.00	do		50	42	E.
20		3.00	49 47 40	64 35 00	55	50	W. by N.
20		8.00	49 11 00	64 07 30	52	49	N. NW.
21	9.23		48 32 00	64 09 00	57	54	N. NE.
21		1.30	48 32 00	64 15 00	59	56	NE.
22	8.00		Off Percé Rock		58	56	Variable.
22	Noon				61	57	SW.
22		4.00			62	59	W.
23		1.40	46 28 00	61 55 00	62	63	NE.
23		9.05	45 42 00	61 28 00	59	64	NE.
24	9.00		45 36 30	61 21 50	65	63	Variable.
25	Noon		45 36 30	61 21 50	62	60	E. SE.
26	8.00		Port Hawksbury		62	60	E. SE.
26	Noon		do		62	60	E. SE.
26		4.00	do		63	60	N.
27		4.30	45 11 00	61 08 00	64	60	NW. by N.
28		6.50	44 33 00	63 00 00	62	62	W. NW.
29		7.00	43 26 00	65 15 00	59	61	E. by S.
30	8.00				60	55	Variable.
30	Noon		43 02 00	65 52 00	64	56	Variable.
30		4.00			60	54	SW.
31	Noon		42 35 06	66 53 45	60	52	E. by N.
Sept. 1	10.30		41 32 28	69 55 00	62	60	N. NE.



CURING-STAGES AT NEWFOUNDLAND. (See page [55].)
From London Illustrated News.

12.—*Table showing localities, results, etc., of trials for fish with "toll bait," hand-lines, etc.*

Date.	Hour. A. M.	Hour. P. M.	Approximate position.	Lat. N.	Long. W.	Apparatus used.	Surface water.	Results.
1887.				° ′	° ′		°	
July 6	8.30	......	Off White Head	....	....	Hand-lines	51	4 codfish.
8	9.45	......	Grindstone Island shore.	....	....	Baird seine	....	Nothing.
9	....	1.00	Small Bird Rock	....	....	Toll-bait	54	Do.
9	....	1.00	...do	....	....	Hand-lines	54	Do.
10	11.00	......	Off Entry Island	....	....	Toll-bait	54	Do.
10	11.00	......	...do	....	....	Hand-lines	54	11 cod, 1 halibut, 2 flounders.
10	....	4.30	Amherst Harbor	....	....	...do	55	Small local fish.
13	....	2.00	S. SE. Entry Island	....	....	Toll-bait	55	5 cod, 1 halibut.
28	....	4.00	Off Bay Verte	....	....	...do	55	Nothing.
Aug. 9	5.30	......	Off Eastern St. Mary's Island.	....	....	Hand-lines	53	Do.
10	....	7.48	Off Large Island, Mingan group.	....	....	...do	40	1 cod.
15	....	1.00	Off Mingan Island	....	....	Toll-bait	44	Nothing.
15	....	8.00	...do	....	....	Squid jigs	44	Do.
16	8.00	......	...do	....	....	Toll-bait	45	Do.
21	6.50	......	Off Percé	....	....	...do	54	Do.
21	6.50	......	Cape Gaspé, North Percé Mountain, W. NW.	....	....	Hand-lines	54	Do.
30	....	4.00	At sea	42 58	66 06	...do	....	1 cod, 1 cusk.

13.—*Table showing positions, etc., where small surface towing-net was used.*

Date.	Hour. A. M.	Hour. P. M.	Approximate position.	Lat. N.	Long. W.	Length of towing.	Surface water.	Results.
1887.				° ′	° ′	*Min.*	°	
July 3	....	7.00	Gulf of Maine	....	67 25	60	58	Small crustaceans and insect larvæ.
6	8.30	......	Off White Head	....	....	90	51	Small crustaceans and fish eggs.
29	6.30	......	Off Canada Head	....	....	60	48	Crabs in larval stages.
Aug. 9	10.00	......	Off Cape Whittle	49 52	60 21	60	57	Medusæ.
10	8.00	......	Off Mingan Island	....	....	60	55	Nothing.
21	8.00	......	Off Bonaventure Island	....	....	....	....	Do.
23	7.00	......	Gulf of St. Lawrence	....	....	40	....	Do.
30	8.00	......	Off Cape Sable	43 02	65 51	120	55	Do.
30	....	4.00	Near Brown's Bank	42 58	66 06	60	54	Small crustaceans.

III.—REPORT UPON THE OPERATIONS OF THE GRAMPUS FROM SEPTEMBER 16, 1887, TO MARCH 24, 1888.

By J. W. Collins.

A.—REFITTING AND COPPERING THE VESSEL, ETC.

The previous report upon the operations of the *Grampus* concluded September 16, 1887; at that date she arrived at Gloucester to refit for her winter's work of collecting live cod and allied species, as well as the eggs of the *Gadidæ*, for the purpose of propagation. This section will, therefore, be a review of her winter's work.

Soon after the arrival of the vessel at Gloucester, certain necessary alterations were made in the new sails, which had been bent for the trip to Newfoundland and Labrador. The winter sails were put in order for service, the vessel was painted, and all available time was utilized for putting the rigging into proper shape.

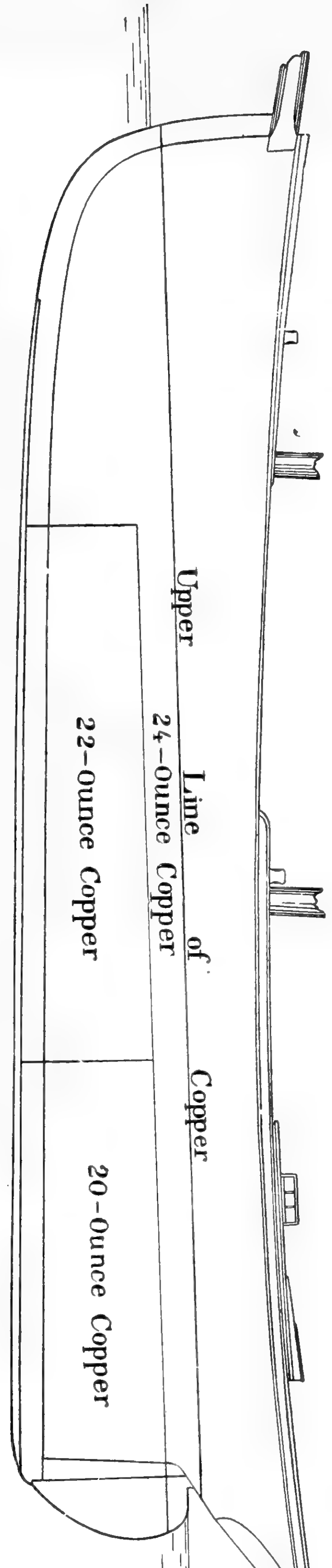
It was deemed very important that the vessel's bottom and the interior of the well should be coppered, to obviate the danger of injury to the plank from being worm-eaten. The Commissioner, Prof. G. Brown Goode, had the matter under consideration early in September, but owing to various causes, among which was my absence from the vessel, no definite action was immediately taken.

In the mean time, soon after the arrival of the *Grampus* at Gloucester, I was ordered to Washington to superintend the preparation of a series of large maps showing the distribution of the principal food-fishes along the Atlantic coast from Hatteras to Labrador, and the grounds usually resorted to by the fishermen when in pursuit of those species. These maps, which also showed the principal fishing towns, the limits in Canadian waters from which American fishermen are excluded by the treaty of 1818, etc., were prepared for the use of the International Fisheries Commission, which met in the winter of 1887-'88 at Washington, to negotiate a new fisheries treaty. The Commissioner also deemed it important that I should be in Washington for consultation in reference to fishery matters bearing upon the negotiations.

Having ordered the first officer to assume command of the vessel during my absence, I left Gloucester on September 20, and reached Washington the following day. As soon as the work of the preparation of the maps was organized, I left Washington (on the 27th of September) under orders from the Commissioner to return to Gloucester and prepare specifications and obtain bids for coppering the *Grampus*.

The following bids were received and opened on November 1:

Messrs. William F. Green & Son, Boston, Mass	$1,250
Messrs. Bliss Brothers, Boston, Mass	1,290
E. A. Costigan, Boston, Mass	1,750
Messrs. Burnham Brothers, Gloucester, Mass	1,594



SHEER PLAN OF SCHOONER GRAMPUS, SHOWING AREA COVERED WITH COPPER SHEATHING, ETC.

Drawn by E. I. Rogers.

The bid of William F. Green & Son proved to be the most advantageous to the Government, and accordingly the contract was awarded them.

Having completed and sent out the specifications and invitations for bids for coppering the vessel, I left Gloucester on October 15 for Washington, in compliance with instructions from the Commissioner. As is usual before leaving the vessel, I placed her under the command of the first officer, with instructions to act in accordance with orders sent him from Washington from time to time.

Mention may be made that, while at Gloucester on the 6th of October, I made an examination of Ten Pound Island, in compliance with the request of Col. Marshall McDonald, and reported to him on October 7 the condition of the island and its suitability as a site for a hatchery for marine fishes, and suggested that the northeast part of the island would be the most suitable location for a hatchery.

On November 9 I was again ordered to proceed to Gloucester, in company with Colonel McDonald, for special duty in connection with the establishment of a fish hatchery at Ten Pound Island, after which I was to return to Washington.

The *Grampus* left Gloucester on November 12 to go to Boston for the purpose of being coppered. She was taken on the marine railway at East Boston on the 14th. On the same day I went to Boston for the purpose of inspecting the vessel before the work of coppering her was begun. Having made satisfactory arrangements and given instructions to the contractors, I left Boston the same afternoon and arrived in Washington the following day.

The contractors finished coppering the vessel on November 18, and immediately after she went to Gloucester, arriving there on the afternoon of that day.

The schooner remained at Gloucester until the 21st, when she sailed for Wood's Holl, which place she reached on the 23d. She lay at Wood's Holl until November 26. In the mean time the summer suit of sails was unbent and the winter sails put in their place; the foretopmast was sent down and various other changes were made in her outfit and equipment. As soon as this necessary work had been performed the vessel left Wood's Holl for Gloucester, where she arrived on the afternoon of November 27.

B.—COLLECTING LIVE FISH.

It was intended that the *Grampus* should at once enter upon the work of collecting live codfish for the purpose of propagation. But, because of the scarcity of bait, she was unable to commence active operations until the 4th of December. In the interim every effort was made to obtain bait from other towns, but none could be secured until the evening of December 3, when a supply was received from Provincetown.

She began fishing with hand-lines on the rocky shoals 4 or 5 miles distant from Eastern Point, and continued this work whenever the weather permitted until the end of the month. In the mean time some live-cars had been built and moored near Ten Pound Island, and the cod were on suitable occasions transferred from the well to the cars.*

As usual on the New England coast, the weather was rough and windy throughout December, and as a consequence there were only twelve days that were suitable for fishing; on one of these an anchor was lost, and, as the wind blew up strong soon after, the vessel returned to port.

Notwithstanding the adverse conditions, a total of 946 cod and 6 pollock were taken on handlines, of which, however, 357 cod and 5 pollock died in the well or in the live-cars before the close of the month, leaving 589 cod and 1 pollock alive as a result of the fishing in December.

Between Christmas and the 1st of January the cod apparently moved off the rocky shoals into deeper water, and it became necessary to use trawl lines. Trawls were set for the first time on January 2 and hauled on the next day, with indifferent success, only 21 cod, 2 hake, and 1 haddock being taken. Fishing with trawls was continued until the 6th of January, but comparatively few fish were taken.

In compliance with orders from the Commissioner, I left Washington on December 20, in company with Colonel McDonald, who went to make a final inspection of Ten Pound Island Hatchery, and to make any additional arrangements that might seem necessary for supplying it with fish eggs during the winter. We reached Gloucester on December 21, and on the next day made a trip to the fishing grounds on the *Grampus*. I remained in Gloucester until January 4, when I left there and arrived in Washington on the following day.

Soon after this, however, the weather became much colder, and the temperature of the water in the harbor fell so low that ice began to form, and shortly all the fish in the well of the *Grampus* and those that had been placed in the live cars died. Unfortunately, too, this occurred before the hatchery was fully completed, and thus the eggs which might otherwise have been obtained from the live fish were not secured.

C.—COLLECTING FISH EGGS.

Since the weather continued very cold and the harbor was frozen over to a greater or less extent, it was evidently of no use to catch live fish, for they would die as soon as the vessel entered the harbor. In a letter dated January 5, Mr. Robinson, superintendent of the hatchery, made the following suggestion for collecting cod eggs from the fishermen:

"I am sure that we can secure more eggs by keeping some of our force on the *Grampus* to collect the spawn than by catching the fish and penning them. Capt. D. E. Collins is of the same opinion."

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* For details see Table 1.

This method had been adopted the previous year with good success, and there was reason to anticipate that excellent results might be obtained.

The first trip for collecting eggs was made on January 14, and on that occasion 7,056,000 cod eggs were obtained. This method of supplying the hatchery was continued during the remainder of the season.

The total number of fish taken, the dates upon which fishing was carried on, etc., and also the aggregate number of eggs collected during the season, are shown in Tables 1 and 2. The temperature of the sea and air is shown in Table 3.*

Reference is made to the report upon the construction and equipment of the *Grampus*, for a description of the methods employed in obtaining fish and eggs on board the vessel.

D.—DIFFICULTIES ENCOUNTERED IN THE WORK.

The weather throughout the winter continued exceptionally severe, and it was frequently difficult to obtain eggs, even when fish were caught, owing to the low temperature, which chilled the ova before they could be taken on board the *Grampus*, although the utmost care was observed. The following mention, taken from the log-book under date of January 24, will illustrate the difficulties often met with:

"From 8 a. m. to 12 m.: Wind northwest, increasing from a stiff breeze to a moderate gale; weather clear and cold. One spawn-taker boarded schooner *Hector*, but nothing could be done in the way of collecting eggs, as the fish would freeze in a very short time after being taken from the water."

Outside of the frequent recurrence of such difficulties, no incident demanding special attention seems to have occurred, excepting on the 15th of February. On that date the *Grampus*, as usual, left Gloucester in the early morning. There was a stiff breeze off the land, but a promise of a fairly good day for fishing. Reaching the grounds, about 12 miles from the land, two dories were sent on board the fishing schooners to collect eggs. Shortly before noon the wind piped up sharply from the northwest, promising a hard thrash to windward to reach Gloucester. At the same time the temperature fell rapidly, and the vessel's deck and rigging were soon covered with ice, since the flying spray froze wherever it fell.

One dory, with her crew of two seamen, returned on board the *Grampus*, leaving the spawn-taker on board the fishing vessel, where he preferred to stay rather than take the risk of making a passage in a small boat from one vessel to the other with such a gale blowing. The *Grampus* then stood along to pick up her other dory. But before she arrived near the schooner, astern of which the boat was towing, the painter parted and the dory was set adrift. By skillful maneuvering

* Bottom temperatures were not observed previous to March 9.

the boat was picked up by the *Grampus* and hoisted on board, but it was then so rough, and the wind was increasing so rapidly, that it was not considered quite safe to send for the two men then on board the fishing schooner, who it was supposed would reach Gloucester Harbor without special difficulty. This expectation was not realized, however, for the schooner upon which the two men were was unable to reach Gloucester in the teeth of the gale then blowing. She, therefore, kept off for Provincetown, but in running across Massachusetts Bay the sea broke upon her to such an extent as to completely fill her decks, rendering it necessary to knock off her bulwarks to prevent her from foundering. At the same time she sprung aleak, and it was with great difficulty that she was kept afloat until she reached the shelter of Provincetown Harbor, where she had to remain two or three days before she could return to Gloucester. Capt. D. E. Collins briefly reported the return of these men as follows:

"Our men got back from Provincetown Sunday, at 12:30 a. m. They had a rough time getting over to Provincetown and came near swamping before reaching there."

This simple statement will give some idea of the severity of the gale.

Fortunately, the mainsail of the *Grampus* was single-reefed when she left the harbor; for she was so short-handed, owing to the absence of two out of five of her seamen, that it was believed to be impracticable to reef the sails, which were coated with ice and stiff as sheets of iron. And, even if the mainsail could have been double-reefed, there was not sufficient force to hoist it. It was evident that the single-reefed mainsail must not be lowered, if the vessel could possibly stand up under it, with the jib and forestaysail set. "There was too much wind for comfort under that sail," wrote Captain Collins, and the fact that he stood at the wheel for six hours, not daring to leave it in the hands of another until anchor was dropped in Gloucester Harbor, is evidence of the lack of comfort, particularly as his face was badly frost-bitten on both cheeks, and his clothing was covered with sheets of ice.

In reviewing the winter's work it seems desirable to call attention to various causes which operated against the obtainment of complete success. In the first place, much time was lost in the fall when there was a good school of cod on the shore grounds, while the vessel was waiting to be coppered. Secondly, the delay in completing the hatchery at Ten Pound Island, and the death of the fish in the live cars, prevented the Commission from reaping benefits which it otherwise would have derived from the live cod that were collected. The work was again very much interfered with and retarded by the fact that the density of the sea water in Gloucester Harbor decreased so materially during March and April (presumably as a result of the melting snows) that, although quantities of eggs were collected, they would not float, and consequently most of them died on the bottom of the hatching boxes.

E.—COMPLETION OF THE WINTER WORK.

On March 24, in compliance with orders from the Commissioner, the work of collecting cod eggs ceased, and the vessel was re-fitted for a cruise of investigation to the southern mackerel grounds, of which an account is given in the succeeding section of this report.

F.—TABULATED STATEMENTS.

TABLE 1.—*Showing time occupied in line fishing, fishing grounds resorted to, results, etc., December 4, 1887, to January 6, 1888.*

Date.	Fishing grounds.	Bait.	No. fish caught.		No. fish dead.		Depth of water—fathoms.	Time occupied.*	Remarks.
			Cod.	Pollock.	Cod.	Pollock.			
1887.								h. m.	
Dec. 4	Thatcher's Id. NE. by N., Eastern Point N. by E.	Herring	112	3	19	3	26	6 40	
6	Thatcher's Id. N. ½ E., 3½ miles distant.	... do	33	1	......	......	30	6	
7	Eastern Point N. by E. ½ E., Baker's Id. WNW.	....	70	2	24	2	....	6	
9	Eastern Point N., Baker's Id. W. by N. ½ N.	Clams and spurling.	113	......	35	......	27½	7	
12	Eastern Point N. by E. ½ E., Baker's Id. W. by N. ½ N.	Squid and herring.	126	......	48	......	23	6	
13	Honey pinks	Herring	72	......	38	......	25	5 25	
14	Eastern Point N. by E. ½ E., Baker's Id. WNW.	....do	21	......	50	......	26	6	Transferred 153 live cod to cars.
15	Honey pinks	....do	65	......	91	......	26	5	
20	Eastern Point N. by E. ½ E., Baker's Id. W. by N. ½ N.	Sea clams.	134	......	20	......	25	5	Transferred 113 live cod to cars on 17th; transferred 90 live cod to cars on 21st.
22	Buff coasts........	....do	75	......	14	......	25½	3	Took 15 dead cod from well on 21st.
23	Eastern Point N. by E., Baker's Id. W NW.	....do	125	......	18	......	25	5	
24	Western Brown's Bank.	Herring	......	......	......	......	....	......	Lost anchor and immediately returned.
1888.									
Jan. 2†	Eastern Point N. ½ E., Baker's Id. N. W. by W.	....	21	(‡)	19	......	....	(§)	
4†	Lazy Bottom.......	Herring	24	......	19	......	30	(§)	Transferred 125 live cod to cars.
6†	Western Brown's Bank.	....do	29	......	......	......	....	(§)	
	Totals	....	1,020	(‖)	395	5	....	......	

*Actual time spent on fishing grounds.
† Using trawls; gear hauled following day.
‡ 2 hake, 1 haddock.
§ All night.
‖ 2 hake, 1 haddock, 6 pollock.

TABLE 2.—*Showing number of eggs collected, dates of collection, and temperatures.*

Date.	Cod eggs.	Temperatures.*			Date.	Cod eggs.	Temperatures.*		
		Air.	Surface water.	Bottom water.†			Air.	Surface water.	Bottom water.†
1888.		°	°	°	1888.		°	°	°
Jan. 3	750, 000	30	40	....	Feb. 21	758, 160	40	35	....
6	180, 000	30	40	....	22	874, 520	37	35	....
7	300, 000	32	40	....	23	1, 958, 480	35	36	....
14	7, 056, 000	35	38	....	24	189, 540	35	36	....
Feb. 1	1, 178, 793	24	35	....	27	379, 080	....	....	....
3	841, 995	31	35	....	Mar. 1	1, 979, 640	25	34	....
4	463, 320	30	35	....	3	63, 180	27	34	....
6	942, 400	32	37	....	10	800, 280	36	32. 5	34. 5
7	884, 520	32	34	....	11	716, 040	36	34	....
13	379, 080	38	34	....	16	736, 920	35	33. 5	35. 6
14	‡2, 959, 525	40	34	....	19	189, 540	28	34	34. 8
15	1, 453, 500	36	33	....	20	84, 240	39	33. 5	35
19	2, 105, 980	30	34	....	22	589, 540	40	34	36

Total number cod eggs collected on fishing grounds	28, 814, 273
Haddock eggs collected on fishing grounds	75, 000
Cod eggs taken from fish in live cars§	2, 540, 000
Total number of eggs for season	31, 429, 273

* Temperatures given in Fahrenheit degrees.
† Bottom temperatures were not observed until March 9.
‡ 75, 000 haddock eggs.
§ Eggs taken from fish caught by vessel and penned in live cars.

TABLE 3.—*Record of temperature of air, surface and bottom water, observed on schooner Grampus from November* 18, 1887, *to April* 2, 1888.

Date.	Approximate position.		Hour.		Temperatures F.			Depth of water.
	Lat. N.	Long. W.	A. M.	P. M.	Air.	Surface water.	Bottom water.*	
1887.	° ′ ″	° ′ ″			°	°	°	*Feet.*
Nov. 18	42 21	70 54		1. 45	48	45		
18	42 34 30	70 40 05		4. 30	41	45		
18	42 37	70 40		7	40	44		
19	42 37	70 40	4		40	44		
19	42 37	70 40	12 m		50	44		
19	42 37	70 40		8				
20	42 37	70 40	4		46	44		
20	42 37	70 40	12 m		50	45		
20	42 37	70 40		8	35	45		
21	42 37	70 40	4		27	43		
21	42 37	70 40	12 m		35	45		
22	41 31 20	69 53 30	6. 30		38	46		
22	41 27	70 17 15	11		40	46		
22	41 28	70 35		5	40	47		
23	41 28	70 35	4		37	46		
23	41 31 10	70 40 05	12 m		50	45		
23	41 31 10	70 40 05		8	46	45		
24	41 31 10	70 40 05	4		45	45		
24	41 31 10	70 40 05	12 m		45	45		
24	41 31 10	70 40 05		8	40	45		
25	41 31 10	70 40 05	4		42	45		
25	41 31 10	70 40 05	12 m		50	45		
25	41 31 10	70 40 05		8	45	45		
26	41 31 10	70 40 05	4		50	45		
26	41 28 40	70 34	9. 25		58	47		
26	42 03	70 01		6. 10	49	47		
27	42 24	70 25	4		45	47		
27	42 34 30	70 40 05		2. 30	56	45		
27	42 37	70 40		8	48	45		
28	42 37	70 40	4		49	45		
28	42 37	70 40	12 m		54	45		
28	42 37	70 40		8	40	45		
29	42 37	70 40	4		32	44		
29	42 37	70 40	12 m		38	45		
29	42 37	70 40		8	26	45		
30	42 37	70 40	4		23	43		
30	42 37	70 40	12 m		30	44. 5		

* Not recorded until March 9, 1888.

TABLE 3.—*Record of temperature of air, surface and bottom water, etc.*—Continued.

Date.	Approximate position.		Hour.		Temperatures F.			Depth of water.
	Lat. N.	Long. W.	A. M.	P. M.	Air.	Surface water.	Bottom water.*	
1887.	° ′ ″	° ′ ″			°	°	°	*Feet.*
Nov. 30	42 37	70 40		8	17	44		
Dec. 1	42 37	70 40	4		15	42		
1	42 37	70 40	12 m		18	42		
1	42 37	70 40		8	20	42		
2	42 37	70 40	4		14	40		
2	42 37	70 40	12 m		29	41		
3	Gloucester Harbor		4		40	40		
3	do		12 m		45	42		
3	do			8	34	42		
4	do		3		40	41		
4	42 25 30	70 39	7		40	44		
4	42 25 30	70 39	12 m		43	45		
5	Gloucester Harbor		4		42	41		
5	do		12 m		44	41		
5	do			8	39	41		
6	42 35	70 33 10	7.30		31	44		
6	42 35	70 33 10	12 m		34	43		
6	Gloucester Harbor			7	36	40		
7	do		4		28	41		
7	42 31	70 40	6.40		34	44		
7	42 31	70 40	12 m		42	44		
7	Gloucester Harbor			7	38	42		
8	do		4		39	41		
8	do		12 m		47	41		
8	do			8	36	41		
9	do		4		36	41		
9	42 31 10	70 40	7		35	44		
9	Gloucester Harbor			8	30	41		
10	do		4		38	41		
10	do		12 m		45	41		
10	do			8	42	41		
11	do		4		45	42		
11	do		12 m		48	42		
11	do			8	48	42		
12	do		4		43	41		
12	42 31	70 40	7.15		45	45		
12	42 31	70 40	12 m		51	45		
13	42 28	70 38 30	7.15		36	45		
13	42 38	70 38 30	12 m		40	45		
13	Gloucester Harbor			8	34	42		
14	do		4		30	40		
14	42 31 20	70 40	6.45		30	44		
14	42 31 20	70 40	12 m		47	45		
15	42 32	70 37	7.35		41	43		
15	42 32	70 37	12 m		45	44		
15	Gloucester Harbor			7	38	43		
16	do		4		35	43		
16	do		12 m		35	43		
16	do			5	33	42		
17	do		4		28	41		
17	do		12 m		40	42		
17	do			7	34	41		
18	do		5		38	41		
18	do		11		35	41		
18	do			6	32	41		
19	do		4		31	40		
19	do		12 m		40	41		
19	do			8	30	41		
20	do		4		29	40		
20	42 31 00	70 36 10	12 m		45	43		
20	Gloucester Harbor			4	37	42		
21	do		4		35	40		
21	do		12 m		35	42		
21	do			8	35	42		
22	do		4		29	40		
22	42 33 00	70 34 40	10		34	42		
22	Gloucester Harbor			4	25	41		
23	do		4		15	40		
23	42 31 00	70 36 00	12 m		28	42		
23	Gloucester Harbor			7	17	40		
24	do		4		18	34		
24	42 31 00	70 36 00	8		27	42		
25	Gloucester Harbor		4		32	40		
25	do		12 m		32	40		
25	do			8	28	40		
26	do		4		28	39		

* Not recorded until March 9, 1888.

TABLE 3.—*Record of temperature of air, surface and bottom water, etc.*—Continued.

Date.	Approximate position.		Hour.		Temperatures F.			Depth of water.
	Lat. N.	Long. W.	A. M.	P. M.	Air.	Surface water.	Bottom water.*	
1887.					°	°	°	*Feet.*
Dec. 26	Gloucester Harbor		12 m		31	39		
26	do			8	32	39		
27	do		6		25	38.5		
27	do		12 m		24	38.5		
27	do			8	18	38		
28	do		4		20	35		
28	42 31 00	70 39 05	8		39	41		
28	Gloucester Harbor		12 m		40	37		
28	do			8	45	38		
29	do		4		20	38		
29	do		12 m		25	37		
29	do			4	16	37		
29	do			7	10	37		
30	do		4		09	34		
30	do		12 m		08	34		
30	do			4	11	34		
30	do			8	10	34		
31	do		4		03	33		
31	do		12 m		13	34		
31	do			6	14	32		
1888.								
Jan. 1	do		4		34	34		
1	do		12 m		40	34		
1	do			4	41	34		
2	do		4		41	35		
2	42 32 10	70 40 00	10.45		40	39		
2	Gloucester Harbor			4	32	35		
3	do		4		25	34		
3	42 32 10	70 40 00	10		30	40		
3	Gloucester Harbor			4	26	34		
4	do		4		22	33		
4	42 31 30	70 40 00	11		25	40		
4	Gloucester Harbor			4	28	35		
5	do		5		20	40		
5	42 31 30	70 40 00	9		22	40		
5	Gloucester Harbor			4	22	35		
6	do		4		04	34		
6	42 31 30	70 40 00	10.30		26	40		
6	Gloucester Harbor			6	32	34		
7	do		5		38	35		
7	42 31 30	70 40 00	10		32	40		
7	Gloucester Harbor			4	35	35		
8	do		6		33	34		
8	do		12 m		32	34		
8	do			4	34	35		
9	do		4		18	34		
9	do		12 m		21	34		
9	do			4	23	34		
10	do		4		20	35		
10	do		12 m		25	34		
10	do			4	22	34		
11	do		4		20	34		
11	42 30 20	70 38 00	7		21	38		
11	Gloucester Harbor		12 m		25	34		
12	do		4		05	34		
12	do		12 m		11	34		
12	do			4	15	34		
13	42 31 10	70 36 00	8		16	38		
13	Gloucester Harbor		12 m		28	34		
13	do			4	35	34		
13	do			7	36	34		
14	do		4		31	34		
14	42 31 20	70 32 30	7.30		35	38		
14	Gloucester Harbor		12 m		35	35		
15	do		4		35	34		
15	do		12 m		37	34		
15	do			4	33	34		
16	do		4		09	32		
16	do		12 m		14	33		
16	do			4	13	33		
17	do		5		06	30		
17	do		12 m		20	30		
17	do			5	26	32		
18	do		4		26	32		
18	do		12 m		25	32		
18	do			5	20	32		

* Not recorded until March 9, 1888.

TABLE 3.—*Record of temperature of air, surface and bottom water, etc.*—Continued.

Date.		Approximate position.		Hour.		Temperatures F.			Depth of water.
		Lat. N.	Long. W.	A. M.	P. M.	Air.	Surface water.	Bottom water.*	
1888.						°	°	°	*Feet.*
Jan.	19	Gloucester Harbor		4		12	32		
	19	do		12 m		17	33		
	19	do			8	15	34		
	20	do		4		12	31		
	20	do		12 m		18	32		
	20	do			7	14	32		
	21	do		4		07	31		
	21	do		12 m		11	32		
	21	do			4	08	32		
	22	do		4		−02	30		
	22	do		12 m		09	30		
	22	do			4	09	30		
	23	do		4		01	30		
	23	do		12 m		15	30		
	23	do			4	17	30		
	24	do		4		14	30		
	24	42 32 00	70 31 05	7.15		18	37		
	24	Gloucester Harbor		12 m		20	29.5		
	25	do		4		−05	29.5		
	25	do		12 m		01	29.5		
	25	do			4	17	29.5		
	26	do		4		38	30		
	26	do		12 m		25	30		
	26	do			4	26	30		
	27	do		4		05	30.5		
	27	do		12 m		09	31		
	27	do			6	05	31		
	28	do		4		−05	30		
	28	do		12 m		03	30		
	28	do			8	−02	30		
	29	do		4		−05	29		
	29	do		12 m		10	29		
	29	do			4	13	29		
	30	do		4		12	29		
	30	do		12 m		25	29		
	30	do			8	21	29		
	31	do		4		15	29		
	31	42 34 30	70 39 30	8		23	35		
	31	Gloucester Harbor			4	25	29		
Feb.	1	do		4		17	29		
	1	42 34 00	70 39 00	8		18	34		
	1	Gloucester Harbor			4	26	29		
	2	do		4		17	29		
	2	42 34 00	70 39 00	7		20	35		
	2	Gloucester Harbor			4	28	29.5		
	3	42 27 00	70 37 00	7		27	35		
	3	Gloucester Harbor		12 m		32	30		
	3	do			4	32	29.5		
	4	do		5		23	30		
	4	42 30 20	70 27 00	7		26	35		
	4	42 30 20	70 27 00	10		30	35		
	5	Gloucester Harbor		4		35	29		
	5	do		12 m		45	30		
	5	do			4	42	32		
	6	do		5		34	30		
	6	42 39 20	70 34 30	7.15		36	34		
	6	42 48 00	70 36 00	12 m		32	35		
	7	Gloucester Harbor		5		27	30		
	7	42 35 20	70 32 00	8		35	34		
	7	42 34 40	70 42 00	2.35		30	34		
	8	Gloucester Harbor		4		31	32		
	8	do		12 m		34	31		
	8	do			4	35	31		
	9	42 31 00	70 27 00	4		17	33		
	9	42 31 00	70 27 00	12 m		20	33		
	9	Gloucester Harbor			4	20	31		
	10	do		4		03	30		
	10	do		12 m		15	30		
	10	do			4	18	30		
	11	do		5		20	32		
	11	do		12 m		24	32		
	11	do			4	24	32		
	12	42 28 00	70 20 00	8		25	36		
	12	42 28 00	70 20 00	12 m		30	36		
	12	Gloucester Harbor			4	30	32		
	13	do		4		25	32		

* Not recorded until March 9, 1888.

TABLE 3.—*Record of temperature of air, surface and bottom water, etc.*—Continued.

Date.	Approximate position.		Hour.		Temperatures F.			Depth of water.
	Lat. N.	Long. W.	A. M.	P. M.	Air	Surface water.	Bottom water.*	
1888.	° ′ ″	° ′ ″			°	°	°	*Feet.*
Feb. 13	42 28 00	70 20 00	12 m		36	34		
13	Gloucester Harbor			6	32	32		
14	42 34 00	70 40 00	5.45		32	34		
14	42 31 00	70 32 00	7		34	34		
14	Gloucester Harbor			6	42	32		
15	42 27 00	70 20 00	8		36	33		
15	42 27 00	70 20 00	10		32	33		
15	Gloucester Harbor			5	11	32		
16	do		4		—01	30		
16	do		12 m		09	30		
16	do			8	11	30		
17	do		4		20	30		
17	do		12 m		34	30		
17	do			4	31	30		
18	do		4		24	30		
18	do		12 m		34	30		
18	do			4	32	30		
19	42 40 00	70 22 00	7		27	34		
19	42 40 00	70 22 00	10.15		30	34		
19	Gloucester Harbor			4	30	31.5		
20	do		5		35	32		
20	do		12 m		37	32		
20	do			7	38	32		
21	do		4		42	43		
21	42 27 00	70 35 00	11		40	35		
21	42 27 00	70 35 00		2	40	35		
22	42 26 00	70 23 30	9		35	35		
22	42 26 00	70 23 30	12 m		36	35		
22	Gloucester Harbor			6	35	32		
23	40 32 00	70 35 00	5		20	36		
23	40 26 30	70 31 00	10		33	36		
23	Gloucester Harbor			5	35	34		
24	40 32 00	70 35 00	8		35	36		
24	40 32 00	70 35 00	12 m		35	36		
24	Gloucester Harbor			8	32	35		
25	42 20 00	70 20 00	8		36	36		
25	Gloucester Harbor		10		36	35		
25	do			4	36	35		
26	do		5		34	35		
26	do		12 m		42	35		
26	do			4	41	35		
27	do		4		29	34		
27	do		12 m		33	34		
27	do			4	33	34		
28	do		4		13	34		
28	do		12 m		14	34		
28	do			7	10	34		
29	do		4		09	32		
29	42 32 00	70 34 00	12 m		22	35		
29	42 33 30	70 41 00		6.15	24	35		
Mar. 1	42 27 30	70 28 00	8		35	34		
1	42 27 30	70 28 00	10		25	34		
1	Gloucester Harbor			3	32	34		
2	42 35 00	70 30 00	8		22	34		
2	Gloucester Harbor			1	26	33		
2	do			4	32	33		
3	do		4		26	33		
3	42 27 40	70 22 30	10		28	34		
3	Gloucester Harbor			4	30	34		
4	do		4		15	32		
4	do		12 m		26	32		
4	do			4	28	32		
5	do		4		16	32		
5	do		12 m		28	32		
5	do			4	32	33		
6	42 35 20	70 30 00	8		25	33.5		
6	42 35 20	70 30 00	10.30		23	33.5		
6	Gloucester Harbor			4	27	33		
7	42 38 00	70 32 00	5.10		16	33.5		
7	42 55 00	70 35 00		12.20	25	34		
7	Gloucester Harbor			4	26	33		
8	42 36 00	70 34 30	7		22	33		
8	42 34 40	70 29 30	9		26	35		
8	Gloucester Harbor			2	35	32		
8	do			5	34	32		
9	42 34 10	70 36 00	7.40		31	33	35.6	35

* Not recorded until March 9, 1889.

TABLE 3.—*Record of temperature of air, surface and bottom water, etc.*—Continued.

Date.	Approximate position.		Hour.		Temperatures F.			Depth of water.
	Lat. N.	Long. W.	A. M.	P. M.	Air.	Surface water.	Bottom water.*	
1887.	° ′ ″	° ′ ″			°	°	°	*Feet.*
Mar. 9	Gloucester Harbor		12 m		40	34		
9	do			5	38	34		
10	42 40 00	70 26 00	4.15		35	34		
10	42 48 20	70 41 00	10.55		36	32.5	36	
10							34.5	
10	42 50 00	70 34 30		1.30	35	33		
11	Gloucester Harbor		4		30	34		
11	do		8		36	34		
11	42 31 00	70 30 00	12 m		36	34		
12	Gloucester Harbor		4		34	34.5		
12	do		12 m		34	34.5		
12	do			4	33	34		
13	do		4		31	33		
13	do		12 m		28	33		
13	do			4	28	33		
14	do		4		34	33.5		
14	do		12 m		35	33.5		
14	do			4	36	33.5		
15	do		4		31	34		
15	do		12 m		45	34		
15	do			4	46	34		
16	42 39 00	70 33 00	4		35	33		
16	42 52 30	70 42 00	9.30		38	33		
16	42 51 30	70 39 00	11.20		35	33.5	35.6	45
17	42 40 00	70 39 00	6.30		30	33		
17	Gloucester Harbor		12		28	33		
17	do			4	26	33		
18	do		5		15	33		
18	do		12 m		34	33		
18	do			4	29	34		
19	42 40 00	70 27 00	1.40		20	34		
19	42 46 30	70 34 00	10.15		27	34	34.8	
19	42 44 00	70 36 00		12.45	28	34		
20	42 36 00	70 31 30	8		35	33.5		
20	42 39 00	70 27 00	10		38	33.5	35	45
20	Gloucester Harbor			4	43	34		
21	do		4		40	34		
21	do		12 m		41	34		
21	do			4	45	34		
22	do		4		35	34		
22	42 22 30	70 22 00	11.10		40	34	36	58
22	Gloucester Harbor			9	32	34		
23	do		5		19	34		
23	do		12 m		25	34		
23	do			4	26	34		
24	do		4		12	33		
24	do		12 m		19	33		
24	do			4	25	33		
25	do		6		12	33		
25	do		12 m		25	33		
25	do			4	31	33.5		
26	do		5		25	33		
26	do		12 m		35	33.5		
26	do			4	33	34		
27	do		5		38	34		
27	do		12 m		38	34		
27	do			4	36	34		
28	do		5		34	34		
28	do		12 m		38	34		
28	do			4	43	34.5		
29	do		6		34	34		
29	do		12 m		46	34		
29	do			4	45	34		
30	do		5		33	34		
30	do		12 m		45	34.5		
30	do			4	46	35		
31	do		5		38	35		
31	do		12 m		50	25		
31	do			4	35	35		
Apr. 1	do		5		27	35.5		
1	do		12 m		45	35.5		
1	do			4	45	35.5		
2	do		5		35	35		
2	do		12 m		36	36		
2	do			4	37	36		

* Not recorded until March 9, 1888.

IV.—REPORT UPON THE INVESTIGATIONS MADE BY THE GRAMPUS ON THE SOUTHERN MACKEREL FISHING GROUNDS, ETC., FROM MARCH 24 TO JUNE 30, 1888.

By D. E. COLLINS.

A.—BEGINNING OF CRUISE; INSTRUCTIONS FOR MAKING INVESTIGATIONS.

Having made all necessary repairs and preparations for the spring cruise of observation, I telegraphed to headquarters my intention of sailing from Gloucester for Wood's Holl, Mass., to take on board the additional equipment necessary to pursue the contemplated investigation. Accordingly, we got under way at 9.10 p. m., on April 2, and left Gloucester for Wood's Holl, where we arrived at 5.37 p. m., the next day. Our arrival was immediately telegraphed to Washington, and I received the following telegraphic orders in reply:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 3, 1888.

When ready, sail from Wood's Holl for Hampton Roads. Make such observations and collections as practicable on passage. Telegraph arrival. Instructions and additional equipment will be sent you at Fortress Monroe.

J. W. COLLINS.

Capt. D. E. COLLINS,
Schooner Grampus, Wood's Holl, Mass.

We remained at Wood's Holl until the morning of the 7th, when we sailed from there, in accordance with the above instructions. We had a fair run and anchored in Hampton Roads at 7.05 a. m., on April 10. During the passage we saw no indications of the presence of mackerel, excepting a few sea-geese (*Phalaropus*) at sundown on the 9th, and later in the evening several "pods" of fish were seen from the mast-head, in latitude 37° 27′ N., longitude 74° 48′ W.*

At Hampton Roads the following orders were received in reference to the cruise of observation between Cape Hatteras and Nantucket:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 9, 1888.

SIR: I am directed by the Commissioner to send you the following instructions for your guidance on the cruise which you are about to make for observing the habits, abundance, and movements of the migratory pelagic species which approach the coast north of Hatteras

* The term "pod," as used here, means a small body of fish seen at the surface of the water; it is synonymous with a small school.

during the spring months, and among which the mackerel, menhaden, and bluefish are especially noteworthy.

I will first say that you will take on board at Fortress Monroe certain apparatus which has been sent you from Washington. Among this material are two shad gill-nets that you will use as circumstances may dictate. There is also a device for developing eggs which you may obtain from surface dredging or otherwise, and the use of which will be shown either to you or the expert who may accompany you on the voyage.

Your cruising ground will be, generally, north of Cape Hatteras, though, if occasion seems to demand it, you will feel at liberty to go southward of Hatteras, if by so doing you think you can obtain fuller information in regard to the more important species of migratory fishes.

There will not, as you know, be any mackerel fleet cruising in those waters this year, and, in the absence of fishing vessels, it will be desirable that you should get as much information as practicable from communicating with passing merchant vessels. Should you meet with such, and have the opportunity, you will make inquiries of the masters of the vessels as to whether they have observed fish schooling or not.

In general, your work will be carried on in a manner similar to that pursued by you last year when making observations in the same localities, and you must depend largely upon your own judgment as to the region to be cruised over, and the methods and appliances to be used for the capture of fish or other specimens. I will suggest, however, that during the month of April it is probable that the best results may be obtained between Hatteras and the capes of the Delaware; and, as the season advances, you will probably find it necessary to work farther north in order to keep track of the advancing schools of fish.

In carrying on your work it is important that you should observe, so far as practicable, the following methods:

(1) Make trials with toll-bait during the day, when the weather permits, and as frequently as may seem desirable, say at distances of 15 or 25 miles apart.

(2) Efforts should be made to collect young fish, fish eggs, and other material which can be taken near the surface of the water by the use of towing nets. These should be quite constantly employed during the day, whenever the conditions are favorable.

(3) Gill-nets of various kinds, and with different sizes of mesh, should be set at night whenever practicable.

I send you, herewith, a drawing showing what, in my opinion, is the best method of setting gill-nets. This method is extensively used in Europe, and has this advantage, that if the nets are set from the port side or from the bow, you can, if the weather is too rough to go out in the boats, take them in by passing the warp through a snatch-block and heave them in by means of the windlass, thus relieving your men from the great labor of hauling them in by hand.

(4) Keep careful notes of the number of fish of different species taken in the nets, and also in what part of the net they are caught, whether near the top or at the bottom.

(5) Keep records of temperature, height of barometer, condition of the weather, state of the sea, direction of the wind, etc., as you have usually done when engaged in cruising.

(6) If practicable, it will be well to take bottom temperatures, say two or three times a day, and in every case note the location of the vessel, depth of water, etc.

(7) If any fish are seen schooling, whether at night or day, make a note of it and their abundance. It is especially desirable that the appearance and abundance of mackerel, menhaden, and bluefish should be noted, and type specimens of any of the fish captured should be saved in alcohol.

(8) Note the appearance and approximate numbers of sea birds, such as gulls, gannets, hagdons, jaegers, etc., which generally accompany migratory fish.

(9) You will make trials with hand-lines from comparatively shallow water down to 150 fathoms or more, keeping a record of the investigations made in this manner, together with the position of the vessel, depth of water, number of lines used, kind of bait, and time spent in fishing.

(10) If you have a good opportunity to collect porpoises or other cetaceans, it will be well to get specimens. If you can not preserve the bodies, cut off the heads so that the skulls can be saved.

(11) All material collected should be carefully preserved in bottles, jars, or tanks, in alcohol or otherwise, as circumstances may demand.

(12) If you have an opportunity, it will be well to try the ship's dredge occasionally in moderate depths, and in towing this be very careful to note if there are any adhesive fish eggs among the material which is taken from the bottom. Should there be such, have them placed immediately in your apparatus for developing eggs, and, if possible, carry on the development to the point of hatching out the young fish, in order that we may determine the species.

(13) The Commissioner is very desirous that collections of floating fish eggs may be taken whenever opportunity offers, and in case small quantities are taken they can be placed in the hatching apparatus and developed, if practicable, until the young fish hatch out; and, if possible, should be kept alive at least some days, so that we can determine the species.

(14) In the event that you secure suitable quantities of floating fish eggs, which I assume is altogether possible, judging from the results obtained last spring, it is especially desirable that the collections thus made should be taken to Wood's Holl with as much dispatch as possible, in order that the eggs may be put into the hatching boxes at that station. You will, of course, in case you secure such collections, take all possible precautions to keep the eggs alive in pans, tubs, or other

apparatus you may have on board the vessel, and by frequently changing the water on them.

(15) In all of this work of collecting specimens and fish eggs, as well as in the matter of caring for the material, you will be assisted by a specialist, who will join the vessel as soon as practicable. It is now expected that Dr. Tarleton H. Bean will be able to go with you within one or two weeks, and, if circumstances are favorable, it will be well for you to report at Fortress Monroe or Delaware Breakwater, so that he may meet you after you have made your preliminary cruise.

(16) Always telegraph your arrival in port, and if you have any valuable specimens on board wire the facts. Should you obtain any important information relative to the movements or abundance of fish, give all the facts to the Associated Press agent in any port you may visit.

(17) About the 20th of May you will return to Wood's Holl and take on board the purse seine and seine-boat, after which you will cruise in search of mackerel. If possible, you will surround a school with the seine and take as many live fish in the vessel's well as it may be practicable to carry to Wood's Holl station. The Commissioner deems it very important that we secure a quantity of live mackerel during their spawning season, in order that experiments may be made in artificially propagating that species.

(18) If you succeed in catching any specimens in your gill-nets, or by hook and line, you will be able to judge pretty accurately as to the development of the ovaries and spermaries in the fish, and you will then know about what is the best time to make preparations for proceeding on your cruise for the same.

(19) Report briefly by mail the results of your work.

Very respectfully,

J. W. COLLINS,
Assistant, U. S. Fish Commission.

Capt. D. E. COLLINS,
Commanding, pro tem.,
U. S. Fish Commission Schooner Grampus,
Hampton Roads, Va.

I was also directed to make certain collections for the Department of Agriculture, as follows:*

MEMORANDUM TO CAPT. D. E. COLLINS.

In case you have an opportunity to obtain the livers or oil of various species of fish during your cruise, for instance, such as haddock, pollock, cod, menhaden, etc., it is very desirable that specimens of the oil may be saved as pure as possible by trying it out by means of heat or otherwise. Dr. Taylor, of the Department of Agriculture, who has

* No opportunity was afforded to carry out these instructions.

been making some very interesting experiments with fats and oils, is desirous of getting specimens of fish oil in as fresh and pure a condition as possible. If you can, without inconvenience, obtain such specimens and forward them at the first opportunity, I shall be very glad to have you do so.

Any and all forms of oils from fish or cetaceans should be properly labeled with the name of the species, the locality where it was taken, and date.

J. W. COLLINS.

Dr. Tarleton H. Bean, who intended to meet the vessel at Old Point Comfort, and to make the cruise as naturalist of the expedition, could not join us there on account of illness. Pending his recovery, Col. Marshall McDonald, U. S. Commissioner of Fish and Fisheries, determined to visit the vessel for the purpose of conferring about the proposed investigation, but more particularly to consider the best methods for keeping alive and transporting any floating fish eggs that might be procured. It was also decided that Capt. J. W. Collins should make a visit of inspection, and bring with him to the vessel various forms of apparatus which we were to take for preserving collections, and also a device to be used for developing floating fish eggs. It was not, however, practicable for either the Commissioner or Captain Collins to visit us immediately, and since it was deemed important that a somewhat extended inquiry should be made into the condition of the pound-net fisheries of Chesapeake Bay, with special reference to the catch of shad, I received the following orders to make the investigation, pending the arrival at Old Point Comfort of the Commissioner and Captain Collins:

B.—INVESTIGATION OF THE POUND-NET FISHERIES OF CHESAPEAKE BAY.

1. ORDERS.

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 9, 1888.

SIR: It is the present purpose of the Commissioner to go to Fortress Monroe the last of this week to meet you. I think it possible that he will leave Washington Friday evening, and reach Fortress Monroe Saturday morning. If any contrary decision is arrived at, I will wire you as soon as I learn the fact definitely.

The Commissioner directs me to say that, in the event of your arrival at Fortress Monroe within a day or two, you are to leave there and make a cruise along the east shore of the Chesapeake, as far as Tangier Sound and vicinity, to obtain all the information you can relative to the fisheries now being prosecuted in pounds in that region. After reaching the vicinity of Tangier, you will cross the bay to the mouth of the Rappahannock River, and make similar inquiries about the fisheries on the

west side of the bay, between the Rappahannock and Fortress Monroe. You will, of course, time your movements so as to reach Hampton Roads on Friday, in order that we may meet you there.

If you find it impracticable to fully carry out your inquiry of the fisheries along the Chesapeake, or if you arrive too late to enter upon the inquiry before Friday, you will, of course, be governed accordingly, bearing in mind that you should be at Fortress Monroe when we arrive there on Saturday morning.

I shall plan to take with me any apparatus which it is necessary to send you from here.

Very respectfully,

J. W. COLLINS,
Assistant, U. S. Fish Commission.

Capt. D. E. COLLINS,
U. S. Fish Commission Schooner Grampus,
Fortress Monroe, Va.

2. REPORT UPON INQUIRY.

The foregoing orders to make a reconnaissance of the pound-net fisheries of Chesapeake Bay were carried out as fully as circumstances would permit, and, in accordance with instructions, we returned to Hampton Roads on the evening of Friday, April 13. The results of the inquiry are summarized in the following report:

U. S. COMMISSION OF FISH AND FISHERIES,
Schooner Grampus, Hampton Roads, Va., April 17, 1888.

SIR: I have to report that we arrived in Hampton Roads on the morning of April 10, and soon after anchoring I sent ashore to get the vessel's mail and telegraph my arrival. I waited nearly two hours, thinking it possible that I would receive a reply to my telegram, but none came. During the latter part of the day the wind blew a gale from the southeast and made a landing at Old Point Comfort impracticable. The following morning, the wind and weather being suitable for carrying out the instructions sent me to make inquiries concerning the trap fisheries along the Chesapeake Bay, as far as Tangier Island and the mouth of the Rappahannock River, I was anxious to get under way, feeling that the time was short for doing the work assigned. I sent a boat on shore, however, at 8 a. m., and found that the telegraph office would not be opened until some time later. It was, therefore, impracticable for me to notify you by wire of my departure, and deeming it unnecessary and undesirable to wait any longer I got under way and started up the bay.*

The wind was fresh from the westward, and it would have been im-

* Our inability to receive or send telegrams, as indicated, prevented me from receiving orders that were sent from Washington, and which would have materially influenced the movements of the vessel.

practicable to have made investigations on the east side of the bay on the date of our sailing from Hampton Roads. We therefore worked our way along the west shore of the bay, and on the night of the 11th anchored in Mobjack Bay, where we lay until the morning of the 12th. We then ran across to Tangier Island and made as complete an investigation as was practicable. On the morning of the 13th we left Tangier Island and ran across to Mosquito Point, Rappahannock River, and from thence down to Hampton Roads, where we arrived about 7 p. m.

I desired to carry out the instructions to the extent of pursuing the investigation along the eastern side of the bay as far as Cherrystone, but I found it impracticable to do that and return to Hampton Roads at the time designated in my instructions. However, if I understand the instructions correctly, I believe that the information I have obtained relating to the trap fisheries along the Chesapeake Bay is what is required.*

The following is a brief statement of the facts obtained from interviews with men carrying on the trap fisheries:

Between Old Point Comfort and Back River Light there are nearly 100 fish-traps, employing about 400 men. Many of these traps are taken up about the first of June, and the men who fish them are engaged in fishing during the rest of the season by the menhaden "factory" situated upon Back River, which employs 160 men.

The first shad taken this season were caught on the 15th of March. Thus far this season shad have been more abundant than for several years previous. As a rule, the greatest quantity of shad are taken from the 1st to the 15th of April. Herring are caught somewhat earlier in the season. But little effort is made to catch them, since they are not of much value in the markets.

From the middle of May to the middle of August considerable quantities of blue-fish, mackerel, trout, mullet, and black-fish are taken; also sturgeon are caught occasionally.

On April 10, 1,100 shad were taken from one trap, which is the largest number ever caught at one time by the owner of the trap. I learned, however, that fishing had not been good on the east side of the bay, from Cape Charles to ten miles above it, owing to the prevalence of easterly winds during the spring.

The traps between Old Point Comfort and Back River Light are said to cost on an average $400, and a trap will last three years. The fishermen state that $1,000 are realized from each of the traps in this section of the bay.

Messrs. Brooks, Hutchins & Co., who are owners of fish traps in Mobjack Bay, say that they are catching shad, jacks (hickory shad), alewives, and menhaden. Their first shipment of fish was made on March 30, and was composed chiefly of shad and herring. They state that

* The terms "trap fisheries" and "traps," as used in this report, refer to pound-net fisheries and pound-nets.—J. W. Collins.

more fish have been taken this season than for the past three years. Shad fishing ends in May.

Capt. Joseph Louis, of Mobjack Bay, said that there are one hundred traps from New Point Beach to East River, and at this time shad, hickory shad, herring, and menhaden are being caught in them. On the 9th of April a single specimen of the common mackerel was taken in one of the traps. About March 20 fishing was interrupted by a heavy storm. Nevertheless, the fishermen along this shore have done better, according to Captain Louis, than they have for the past eight years. He thinks there are some three hundred men employed in tending the traps above mentioned, but according to Brooks, Hutchins & Co., there ought to be a larger number, since they estimate four men to a trap, and say these traps cost as much as those farther down the bay.

Captain Louis thinks there are about three hundred traps scattered along the shore from New Point Comfort to the Rappahannock River. The fishery for shad ends about the 1st of June, in that locality, and Spanish mackerel are usually taken about five days later. The fish caught in that region are shipped in sloops to Yorktown and Old Point Comfort, where they are transhipped to the large markets along the Atlantic Coast.

Mr. William Harord, who owns three traps in Mobjack Bay, and who has had twelve years' experience in trap fishing, makes the statement that fish, and particularly shad, are more plentiful this year than ever before. In the spring of 1887 the first shad were taken on April 9, but this year they were caught on March 2. He has taken as many as 800 shad at one haul this season. He states that there are nearly 175 traps between York Spit and New Point Comfort, each of these employing about three men, the men being paid $20 per month. The average cost of fish traps in this region is believed to be not more than than $200. He told me of one man, Mr. Thomas, who owns a trap, having taken 1,150 shad at a single haul on April 11. Mr. Harord says that his traps pay about $500 per year each. He stated very emphatically that, in his opinion, the work of the U. S. Fish Commission is exceedingly beneficial to the fisheries of Chesapeake Bay region, and this appears to be the general opinion of the people engaged in the fisheries in all that region which we visited.

I learned that the first shad taken in 1887, at Tangier Island, were caught on March 27. There are ten traps on Tangier Island, and they are now all taking shad and herring in great numbers, and a few menhaden were also caught. These traps are taken up on the 1st of June, and are put down again in the middle of August. From the 15th of August to the end of the season sea trout and blue-fish are the principal species taken. The traps in this region cost about $400 apiece, and the average sales of fish amount to $800.

In the vicinity of Mosquito Point, Rappahannock River, there are 100 traps, according to Mr. J. H. Smith, and they employ about 300

men. He says that at the present time shad, bass, and alewives (or river herring), are being taken. He estimates the average cost of the traps at this point to be $200 and each will stock $600. The fishery at this point has not been so successful as elsewhere during the present season, and it is said that the more important species of fish were quite scarce farther up the river.

Very respectfully,

D. E. COLLINS,
Commanding pro tem.

Capt. J. W. COLLINS,
Assistant, U. S. Fish Commission, Washington, D. C.

C.—NARRATIVE OF CRUISE FROM APRIL 17 TO APRIL 26.

Immediately after we arrived at Hampton Roads, a boat was sent on shore. She soon returned with Capt. J. W. Collins, who brought the vessel's mail. Among the latter was the following telegraphic order, which, owing to circumstances already recited, I failed to get at the proper time:

[Telegram.]

APRIL 10, 1888.

Capt. D. E. COLLINS,
Schooner Grampus, Hampton Roads, Va.

You will wait at Fortress Monroe. The Commissioner and I expect to leave here to-morrow evening and will be on board the *Grampus* Thursday morning. Acknowledge receipt of dispatch.

J. W. COLLINS.

Expecting that the above order would be received, the Commissioner visited Old Point Comfort, but, of course, did not find us there. Unfortunately, it was necessary for him to return to Washington without delay, and, therefore, he had left on the steamer before we arrived on Friday.

I learned that Dr. Bean would not be able to join the vessel at this time; but it was believed his health would be sufficiently restored in a few days for him to come on board. Captain Collins directed me to proceed with the investigation and to report at Hampton Roads in about ten days, at which time it was expected that Dr. Bean would be sufficiently recovered to accompany the vessel. Captain Collins left on Saturday, the 14th of April, and as soon thereafter as practicable, we got under way and proceeded to sea.

Before we reached Cape Henry the wind suddenly hauled to the northeast, increasing to a fresh breeze, but gradually diminished to a moderate breeze from east-northeast after we passed the Cape. Outside of Cape Henry an east-southeast course was steered, the vessel being close hauled on the port tack. At 11 a. m. the small surface net was put out and towed for forty-five minutes without collecting anything.

We kept on this course throughout the afternoon, with a lookout at the mast-head to watch for schooling fish. Three whales were sighted about 4 o'clock, but nothing else of interest was seen. At 3 p. m., in lat. 36° 45′ N., long. 75° 27′ W., the small towing-net was put out for thirty minutes; nothing was taken in it. Several gannets were noticed during the afternoon, generally on the wing.

In lat. 36° 36′ N., long. 75° 13′ W., the towing-net was again used and we secured a small quantity of marine life, which was preserved in alcohol. During the night the wind continued moderate, varying from east to southeast. The vessel was kept on a southerly course.

In the early part of the following day a southeasterly wind prevailed, hauling to southwest towards noon; weather clear and warm. Sea-geese (*Phalaropus*) and gannets were noticed early in the day, the latter seeming to increase in abundance as we sailed south. We saw indications of the presence of some species of fish in the form of "greasy slicks," although a most careful observation failed to detect any at the surface.

Between 7 and 8 o'clock a. m. a small amount of crustacea was collected in the towing-net, our approximate position being lat. 36° 13′ N., long. 74° 51′ W. At 8 o'clock the vessel was hove-to near this position and a trial for surface and bottom fish was made; the temperature of the water at the bottom was also obtained. The result of this trial was very unsatisfactory, since only one dog-fish was caught. We got under way again at 9.15 a. m. and continued on a southeasterly course. The temperature of the water at the bottom was taken at noon. At 2.30 p. m., in lat. 35° 56′ N., long. 75° 02′ W., hove-to and threw toll-bait for mackerel and put out hand-lines for bottom fish. Two dog-fish, caught on the hand-lines, were the only fish taken. While lying-to gannets were seen diving in the water for fish. Bottom temperature was observed at this position, the depth of water being 17 fathoms.

Got under way again at 3.30 p. m., and stood to the southeast. Towards evening the weather changed, assuming a threatening aspect, which, added to a short, sharp sea that began to make from the southward, prevented us from setting the gill-nets that had been prepared for the purpose. At 6.30 p. m. the large and small towing-nets were put out and towed for thirty minutes, the trial resulting in the capture of five small fish in the large net and a quantity of crustacea in the small net, our position at the time of this trial being lat. 35° 46′ N., long. 74° 55′ W. The vessel was hove-to at dark, heading to the southeast.

The 19th of April began with a moderate south-southwest wind and threatening weather, an increasing sharp sea coming from the south, and in that direction dark nimbus clouds were seen above the horizon, indicating a storm in that quarter. At 3 a. m., the weather assuming a milder appearance, one mackerel and one herring gill-net were set at right angles to the vessel, being sunk $2\frac{1}{2}$ fathoms below the surface. The net warp was made fast to the mainmast of the vessel, which was

hove-to on the starboard tack. The nets were hauled at 5 a. m., but contained no fish. This trial did not fully determine the presence or absence of fish, since it is possible that, under more favorable conditions of weather and a longer trial, different results might have been obtained.

After getting the nets on board, the vessel was headed to the northeast and the small surface-net was towed between 7 and 8 o'clock a. m.; a limited amount of small crustacea was collected. At 7 o'clock the wind suddenly changed to the northwest, and a little later to the northeast, accompanied by a dense fog which lasted about two hours.

At 8 a. m. bottom temperature at a depth of 175 fathoms was taken, and at 10 o'clock the towing-net was put out, which collected a small amount of minute crustacea. During the forenoon small flocks of sea-geese were seen. In lat. 36° 34′ N., long. 74° 34′ W., the large and small towing-nets were used and some copepods and one small butter-fish were collected. During the day the barometer gradually lowered, indicating the approach of stormy weather. The vessel was therefore hove-to during the night, it being deemed unadvisable to attempt to set gill-nets.

On the morning of the 20th there was an easterly wind, with cloudy sky and rain at intervals. At 5 a. m. threw toll-bait to raise mackerel. Hand-lines baited with salt-pork and menhaden were also put out for bottom fish. This trial, which was continued for forty minutes, resulted in the capture of one dog-fish, our position being lat. 36° 39′ N., long. 74° 51′ 31″ W.

Between 6 and 7 o'clock a. m. a school of porpoises passed us, going in a northwesterly direction, but before we could get a harpoon in readiness they were beyond reach. Two large flocks of sea-geese were seen during the morning.

The small towing-net was put out at 8 o'clock and towed for an hour and a half, but failed to capture anything. After completing this trial we got under way and stood to the northeast for 23 miles, when we tacked to the westward. A few sea-geese and occasionally a gannet were noticed on the last course. A lookout was stationed at the mast-head and, notwithstanding that a vigilant watch was maintained, we failed to detect the presence of any surface fish. We continued on the westward course for 12 miles, when we tacked again, heading to the northeast. In lat. 37° 03′ N., long. 74° 49′ W., the small towing-net was used and a limited amount of crustacea was taken in it. On account of the fresh wind and sharp sea it was found impracticable to set the gill-nets, in which I am inclined to think we are more apt to secure evidence of the presence of mackerel or other migratory fish than by using any other form of apparatus.

The morning of the 21st opened with clear and cool weather, a fresh north-northwest breeze and short rough sea, in consequence of which the vessel was kept hove-to the greater part of the forenoon. The wind decreased about 11 o'clock and we got under way, standing to the west-

southwest. At noon tacked to the northward. At 4.30 p. m., in lat. 37° 03′ 45″ N., long. 74° 48′ W., hove-to and threw toll-bait for fifty minutes without succeeding in "raising" any fish. We continued on our course, and a little later put out the large and small towing-nets for about forty minutes. One young fish and some crustacea were taken; our position was lat. 37° 07′ N., long. 74° 48′ W.

Soon after completing the last trial the vessel was hove-to and one mackerel and one herring gill-net were set.

At 5 a. m., on the 22d, we hauled the gill-nets. One small mackerel was caught in the herring-net. The specimen was preserved in alcohol. Got under way at 5.30 a. m. and steered a northerly course. About 6 o'clock put out the little towing-net for one hour and a half, taking in it a small lot of crustacea. At 9 a. m., in about lat. 37° 02′ N., long. 74° 44′ W., a large number of sea-geese were seen scattered in flocks over the surface for a considerable distance; gannets were also abundant, and, in most instances, were sitting on the water. The presence of these birds was apparently no positive indication of the presence of mackerel on this occasion, since a very careful lookout at the mast-head failed to discover any schooling fish. The wind hauled gradually to the eastward, and at 8 o'clock we tacked heading north by west to north-northwest on the starboard tack. The small towing-net was used at 9.40 a. m.; a few sea-fleas and a species of small shrimp were taken in it. At noon threw toll-bait for mackerel, also put out lines for bottom fish and took bottom temperature. No fish were secured in this trial. The position of the vessel at the time of the trial was lat. 37° 22′ N., long. 74° 47′ 30″ W. Later in the afternoon the wind changed to east-southeast and southeast, blowing a moderate breeze, the sky cloudy with indications of rain. At 4.30 p. m. toll-bait was thrown to "raise" mackerel, but with no success. On account of the threatening weather no attempt was made to set gill-nets in the evening.

April 23 began with a moderate southeast wind, a little later hauling to the northeast; sky threatening and stormy. At 6.30 a. m. threw toll-bait, took bottom temperatures, and fished with hand-lines for bottom fish; obtained nothing. The small surface towing-net was used for thirty minutes after finishing the trial, our position being lat. 37° 40′ N., long., 74° 30′ W.

At 9.30 a. m. the wind suddenly backed to northwest, gradually hauling to north by west and increasing in force until about noon, when it blew a gale, with a sharp, rough sea. Hove-to and suspended operations on account of the bad weather. A moderate north to northeast wind prevailed in the early part of the next morning, ending in a calm towards the afternoon. Got under way at 7 o'clock, steering a westerly course. Sounded in 34 fathoms of water at 10 o'clock, and took bottom temperatures. Half an hour later we hove-to and threw toll-bait to attract mackerel; lines were also used for bottom fish. A trial of 50 min-

utes resulted in the capture of a small dogfish on the cod-lines. The position of this trial was lat. 37° 39′ N., long. 74° 38′ W.

Leaving the position of the last trial, we worked to the northeast, the wind varying from a moderate breeze to a light air from that quarter. At 6.45 p. m., took bottom temperatures in 31 fathoms, and at 7 o'clock prepared to set gill-nets. The mackerel net was set at the surface and the herring net 3½ fathoms deeper. The vessel was hove-to on the starboard tack and the net warp made fast to the mainmast.

In the early part of the next day the wind increased to a fresh breeze from the north, and later veered to the north-northeast. Hauled the nets at 4 a. m., taking one branch herring in the mackerel net. At 5 o'clock got under way and kept off on a southwesterly course; changed course later more to the westward, with a view to making a harbor at Hampton Roads to get a supply of water, of which we were in need.

Passed Cape Henry at 3.30 p. m., but owing to a head tide and an adverse wind we did not anchor at Hampton Roads until 6.50 p. m. Immediately after anchoring I went on shore to get the mail and telegraph our arrival.

D.—SUGGESTIONS FOR COLLECTING AND PRESERVING SPECIMENS.

Additional instructions for making observations and caring for specimens, which were prepared by the Assistant in charge of Scientific Inquiry, were received. It may not be out of place to say here that it has been customary on the vessel to carry out such routine as was ordered, since it has always been recognized that the value of the observations, as well as the importance of the collections as study material, depends on the accuracy and completeness of notes on surrounding conditions. The following is a copy of the orders and letter transmitting them:

U. S. Commission of Fish and Fisheries,
Washington, D. C., April 27, 1888.

Dear Sir: I send you, herewith, some suggestions for collecting and preserving specimens, and for making observations, which have been prepared by the Assistant in charge of Scientific Inquiry, and which have been forwarded to me by the Commissioner. As I understand it, you have been carrying on your observations in a manner similar to that required by these suggestions, which you will attach to the instructions for the cruise that I forwarded to you a few days ago, and with which you will comply so far as practicable.

Very truly yours,

J. W. Collins,
Assistant, U. S. Fish Commission.

Capt. D. E. Collins,
U. S. Fish Commission Schooner Grampus, Fortress Monroe, Va.

SUGGESTIONS FOR COLLECTING AND PRESERVING SPECIMENS AND FOR OBSERVATIONS.

Note air temperatures and the state of the weather at regular periods. This is probably your custom at all times.

Take temperatures at the surface regularly, and read the thermometer with great care. Be certain that it has been immersed a sufficient length of time to take the true temperature. Indicate by latitude and longitude, or by a mark on the chart, the exact position where each temperature observation was made. Take the temperature of the air at the same time that you take the temperature of the water.

Preserve all the materials obtained in each towing in a bottle by itself, and label these bottles carefully. Each label should have written on it the date, the time of day, the latitude and longitude, and the length of time the towing net has been out, or the distance it has gone through the water. Make as many towings as possible.

Each time that a lot of mackerel is taken, cut out and preserve the stomachs of several of the fish in a bottle, first cutting the stomachs open so that the alcohol will enter freely. Put labels on these bottles stating the latitude and longitude where the fish were taken, the date, and time of day.

Note the occurrence of every school of mackerel, and of all stray individuals, and their abundance. Note any observations you can make in regard to their movements; in what direction they are going; do they leave the surface and sink for any reason; what is the cause of this?

Note whether the fish contain spawn. Preserve specimens of the fish from time to time in alcohol, first make a very large cut in the ventral side so that the alcohol may freely enter the visceral cavity. Label all such specimens.

Where you find schools of mackerel is there always an abundance of the small surface feed? Make towings at such times.

Do you ever find the schools of mackerel chased by other fish, and by what kinds?

Make notes on the other fishes which you observe.

The following morning received telegraphic orders to wait at Hampton Roads until further instructions arrived, which would be sent by mail. We remained in the harbor from the 26th to the 30th of April, during which time all the necessary stores were taken on board, including a lot of jars, in which to preserve specimens, that were received from Washington.

E.—ORDERS FOR CONTINUING THE CRUISE.

The following instructions in regard to continuing the investigation were received on the morning of April 30:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., April 28, 1888.

SIR: The Commissioner directs that you will proceed to sea, as soon after receiving these orders as practicable, and continue your observations and researches for five or six days, when you will again report at Fortress Monroe or Delaware Breakwater, as may be convenient. Dr. T. H. Bean will then be ready to join you, and it is possible that another specialist may go with you.

The Commissioner is desirous of having you pursue your investigations nearly in the latitude of the Chesapeake Capes, and is anxious to have a series of temperatures taken from comparatively near the coast to nearly to the Gulf Stream, and, so far as practicable, he desires to have bottom temperatures taken as well as those of the surface water and air. I would suggest that you run a line of temperature observations, at distances of about 5 or 10 miles, from near the coast to a depth of, say, 200 fathoms. I believe it will be as well to work out and in nearly on the parallel of Cape Henry or Cape Charles until you return to port again, and, in addition to your temperature observations, you will, of course, continue your other trials and researches as heretofore.

Yours very truly,

J. W. COLLINS,
Assistant, U. S. Fish Commission.

Capt. D. E. COLLINS,
U. S. Fish Commission Schooner Grampus,
Fortress Monroe, Va.

F.—NARRATIVE OF CRUISE FROM APRIL 30 TO MAY 5.

In compliance with the above orders, we got under way at 11 a. m. on the 30th and proceeded to sea. When abreast of Cape Henry our course was laid to the eastward. A series of observations of bottom, surface, and air temperatures was begun at this point and continued at intervals until we reached the eastward of coast soundings.

On the morning of the 1st of May the wind was variable from the west-southwest to south by east. At 3 a. m., sounded in 30 fathoms of water and took bottom temperature. Sounded again at 7 o'clock, and put out small surface towing-net for thirty minutes, collecting a limited amount of material; our position was lat. 33° 43′ 30″ N., long. 74° 47′ W. After completing this towing a northeast one half east course was steered for 20 miles. At 10 o'clock (lat. 36° 56′ 30″ N., long. 74° 21′ W.), threw toll-bait for mackerel, and also took bottom temperature in 270 fathoms of water. Leaving this position we steered west-northwest, at

times regulating our speed in order to make trials with the surface towing-net, in which we collected a small amount of marine life.

In taking bottom temperature at lat. 36° 58′ N., long. 74° 27′ W., 330 fathoms of line were put out without reaching the bottom. However, the observation was recorded at that depth. Noted bottom temperature again at 2.30 p. m., in 220 fathoms of water in lat. 36° 59′ N., long. 74° 32′ W. After making the last observation the small surface towing-net was used for thirty minutes, in which we took a limited amount of crustacea. Sounded again in 34 fathoms and took bottom temperatures. At different times used the small surface net, though we did not find an abundance of mackerel food. At 6 o'clock put out both large and small towing-nets, but on account of the light wind the vessel did not move fast enough to make collections. Later in the evening the sky assumed a threatening appearance, accompanied by sharp lightning, and all sails, with the exception of the foresail, were taken in.

The next day (May 2) began with a variable wind from north by east to north-northeast, with clouded sky and choppy sea. At 6.30 a. m., jib and fore-staysail were set, and the vessel was headed northwest by north on the starboard tack. The small surface net was towed between 6 and 7 o'clock and collected some small shrimp and sea-fleas. The towing occupied about thirty minutes and was made in lat. 36° 53′ N., long. 74° 40′ W. On account of the choppy sea it was found impracticable to use the towing-nets satisfactorily; though several attempts were made, the sea caused the net to leap out of the water. A few sea-birds were seen during the forenoon.

The wind moderated a little after noon, and at 2.43 p. m. we tacked ship to the eastward, and a little later put out the small surface net for thirty minutes (lat. 37° 01′ N., long. 75° 00′ W.). Took bottom temperatures at 4.45 p. m., in 23 fathoms of water. At 6.25 p. m., put out large and small towing-nets and towed them for thirty minutes, collecting a lot of crustacea, principally sea-fleas. About 7 o'clock set one mackerel and one herring gill-net, both nets being sunk to a depth of 2½ fathoms; our position was near that of the last towing.

Hauled the nets at 4 a. m., on the 3d, but found no fish in them. At 5 a. m., got under way, heading towards the north-northwest. Noted the temperature at the bottom before making sail. This course was sailed until we reached the meridian of 74° 57′ W. longitude, when we tacked to the eastward. We ran to the eastward until reaching lat. 36° 59′ N., long. 74° 43′ W., where we took bottom temperatures in a depth of 45 fathoms. After making temperature observations the vessel was headed north-northwest. When in lat. 37° 07′ N., long. 74° 51′ W., large numbers of gannets and sea-geese were noticed, the former sitting quietly on the water, and the latter occasionally rising in large flocks, but again settling on the water.

This gathering of birds, by far the largest yet seen by us (knowing their characteristic habit of following migratory fishes), put us on the

alert to discover the local attraction which induced them to congregate in such numbers at this point. Greasy slicks marked the water, and all external signs of mackerel seemed to be present. However, the most searching scrutiny of the sea surface failed to reveal the presence of any fish. The vessel was hove-to in this locality and toll-bait thrown to attract mackerel, but without success. Cod hand-lines were also used, but bottom fish seemed to be as scarce as others, and in consequence nothing was taken. While throwing toll-bait, a species of small fish (apparently that which is known to the fishermen as "brit"), was noticed to school among the bait. Efforts to capture some of these fish proved fruitless.

After completing this trial we got under way and headed to the northeast. At 6.10 p. m., put out the large and small towing-nets for forty-five minutes and collected an abundance of sea-fleas in the small net, and two small fish in the large one. Hove-to at dark and set one herring and one mackerel gill-net. The mackerel net was placed at the surface and the herring net about $2\frac{1}{2}$ fathoms deeper (lat. 37° 09′ N., long. 74° 47′ W.).

The nets were hauled at 4.30 a. m. on the 4th; one butterfish was taken in the mackerel-net. At 7.30 got under way and kept off, steering north by east for 15 miles. Hove-to and threw toll-bait for thirty minutes; cod hand-lines were also put out for bottom fish, but nothing was taken. At 9.45 a. m. changed course to the southward, and at 10 o'clock the small surface net was towed for thirty minutes, collecting only a few sea-fleas. Later the course was changed to west by south. At 1.45 p. m. tacked ship to the southeast, and at 2 o'clock put out small towing-net, towing it for thirty minutes. A small quantity of sea-fleas and other minute marine life was taken in it. (Position, lat. 37° 07′ N., long. 74° 07′ W.) No attempt was made to set gill-nets in the evening on account of the unfavorable weather.

A moderate southerly wind prevailed during the early part of the 5th, which decreased in force about daylight. Got under way at 5 a. m., steering north-northwest, and at 7 o'clock hove-to to make observations, taking bottom temperatures, throwing toll-bait, and trying with hand-lines for bottom fish. Two dog-fish were the only fish taken. (Position, lat. 36° 59′ N., long. 75° 02′ W.) An examination of the stomachs of the dog-fish showed their prey to be squid and some kind of fish which it was impossible to identify on account of disintegration attending digestion. After completing the trial for fish, the small towing-net was used and took an abundance of sea-fleas. Kept off on a north-northwest course for eight miles, when we changed to W. $\frac{1}{2}$ S., for Cape Henry. At 9.15 a. m. the small surface net was towed for thirty minutes; a quantity of sea-fleas was taken. (Position, lat. 37° 04′ N., long. 75° 16′ W.) The surface net was again put out at 10.30 a. m., collecting a very small amount of sea-fleas, which seemed to indicate that the western edge of the distribution of this species had been nearly reached.

(Position, lat. 37° 02′ N., long. 75° 33′ W.) At noon made Cape Henry, bearing west, and at 6.32 p. m. anchored in Hampton Roads.

Immediately upon anchoring I went on shore to telegraph our arrival and to get the vessel's mail. Received telegraphic orders on the 7th to await instructions by mail.

G.—INVESTIGATION OF MENHADEN IN CHESAPEAKE BAY.

3. ORDERS.

On the morning of the 9th we sailed from Hampton Roads under the following orders, to make an investigation of the spawning habits and other characteristics of the menhaden:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., May 7, 1888.

SIR: I do not think it desirable for you to go outside of the Capes again before you are joined by Dr. Bean. He expects to reach Old Point fully prepared for the cruise by Friday morning. In the interval I wish you, by cruising in the bay and by boarding vessels engaged in the menhaden fishery, to get information in regard to the spawning menhaden, and if possible to procure either the gravid fish or the eggs of the same. With this object in view it is desirable that you should make use of your tow-nets, and the eggs on board of the schooner should be developed to the point when the species may be identified. In the absence of all knowledge of the characteristics of the menhaden, it is of course desirable that no means of investigation should be neglected. My impression, however, is that the egg is heavy and possibly adhesive, and if this be the spawning season the chance of finding eggs of the menhaden will be greater among the material brought up by dredging than that collected from the surface by tow-nets. Without prescribing any specific plan of procedure, I wish you to use your best judgment to get any information in regard to the menhaden.

All young forms of fish taken in tow-nets in the Chesapeake should be preserved most carefully, since the probability is that among the collections made the embryo forms of the same will be present. Please make your arrangements so as to be certainly at Old Point Friday morning on the arrival of the Washington boat.

* * * * * * *

Very truly yours,

M. MCDONALD,
Commissioner.

Capt. D. E. COLLINS,
Commanding Schooner Grampus, Old Point Comfort, Va.

The inquiry ordered by the Commissioner was made with as much promptness as practicable; the results obtained are embodied in the

following report, which was written immediately after our return to Hampton Roads:

4. REPORT UPON INQUIRY.

U. S. COMMISSION OF FISH AND FISHERIES,
Schooner Grampus, Hampton Roads, Va., May 10, 1888.

SIR: In regard to the desired information of the menhaden, and more especially the determination of the period of reproduction of this species, I would say that we left here on the morning of the 9th instant, and proceeded to investigate the waters of the Chesapeake included between Old Point Comfort and York Spit on the west side, and from near the middle ground, off Cape Charles, to Lynn Haven Bay.

This is considered a favorable locality for the occurrence of menhaden at this period, as well as later in the season. The methods used were in accordance with your suggestions, viz: boat dredge, large and small tow-nets. A careful and persistent trial with these forms of apparatus failed to collect either fish eggs or the young fish, the only collections being a species of shrimp secured in the dredge.

Trap fishermen were interviewed at Back River Point, and specimens of menhaden were obtained for examination. About forty of these fish were opened and their ovaries examined, but in every instance they were found in the earlier stages of formation. Specimens have been preserved intact for future reference, as well as the viscera of those examined.

The most important information was obtained from Captain Squires, of the Menhaden steamer *Ida Augusta*, of Onancock, Va. In interviewing him to-day off York Spit Light he said he has been engaged in the menhaden fishery in the Chesapeake for the past seventeen years, and in all of his experience has never found spawning menhaden excepting between the 1st and 20th of October. On two occasions during this period he has seen both the spawn and milt running out of them freely while bailing them out of the seine. He has also attempted to impregnate the eggs on one of these occasions, and says positively that they will not float.

Captain Squires further stated that he has seen this spring, and on former occasions in April and May, the young menhaden about 1 inch in length. The present condition of the fish examined by us, together with the appearance of the young fish alluded to, seem to be corroborative of his testimony, and apparently attaches considerable importance to it.

The sailing schooners which fish for the "factory" on Back River have not commenced operations yet. I am informed that they will begin about July 1st. There did not appear to be any large bodies of menhaden in the localities visited by us. Four steamers, including that commanded by Captain Squires, were fishing off York Spit to-day. I did not have an opportunity to board either of the others while on the

ground, as they were in motion most of the time. One or two small catches were made by them to-day.

I remain, very respectfully,

D. E. COLLINS,
Commanding pro. tem.

Hon. MARSHALL McDONALD,
U. S. Commissioner of Fish and Fisheries, Washington, D. C.

H.—NARRATIVE OF CRUISE FROM MAY 10 TO MAY 25.

We returned to Hampton Roads late on the afternoon of the 10th, and were joined by Dr. T. H. Bean the following morning. The weather was very unfavorable, and consequently we did not leave harbor until the 12th, when we got under way at 7.10 a. m., and at 9.40 Cape Henry bore south about 3 miles distant. Took bottom temperature at 1 p. m. in 12 fathoms of water, our position being lat. 37° 00′ N., long. 75° 32′ W. After taking the bottom temperature the small surface net was towed for twenty-five minutes, and a small quantity of crustacea was taken. Took bottom temperature again at 4 o'clock, and also towed surface net. (Position, lat. 37° 02′ N., long. 75° 01′ W.) In lat. 37° 03′ N., long. 74° 47′ W. at 6 p. m. took bottom temperature and put out small towing-net for an hour, collecting a lot of little jelly-fishes and some crustacea. Hove-to at dark, but did not set gill-nets, since the weather continued unfavorable.

There was a light baffling wind from the north-northwest and a rough sea heaving from the southward in the early morning of the 13th. Got under way at 5 o'clock and headed to the northeast. Made trial with surface net for an hour, in which we secured a few green fish-eggs. (Position, lat. 36° 59′ N., long. 74° 41′ W.) Used the same form of apparatus from 9.30 until 11 o'clock, collecting more fish eggs.

At 11.45 a. m. tacked ship to the north, the wind having worked around to northeast accompanied by foggy weather. At 4.30 p. m., in lat. 37° 15′ N., long. 74° 48′ W., towed the small surface net for thirty minutes and collected an abundance of sea-fleas in it. Put out both the large and small surface nets at 6.30 p. m. and towed them for fifty minutes, collecting a lot of small crustacea in the small net and nothing in the larger one. Took bottom temperatures at 7.25 p. m. in 26 fathoms of water. The vessel lay-to "jogging" under lower sails during the night.

Put out the small surface net for an hour at 5 a. m. on the 14th, taking in it a quantity of crustacea and small floating shells. (Position, lat. 37° 16′ N., long. 74° 50′ W.) Near this locality, between 5.30 and 7 o'clock, we saw what we believed to be three schools of fish, though it is impossible to say positively what species they were. Hove-to and threw toll-bait and used cod hand-lines baited with salt menhaden. Caught only two skates on the hand-lines, from which a number of parasites were taken. After completing this trial the vessel was kept-off

on a northeast ½ north course. In the position approximating that given for the last trial we put out the small towing-net and collected a quantity of crustacea in it. Saw a few gulls and two or three gannets, also greasy slicks, indicative of some species of fish near the surface. Our course was changed to north-northeast at 12.30 p. m., the wind blowing a moderate breeze from south-southwest to south. About 5 o'clock a large school of porpoises came alongside. We succeeded in harpooning one of them, but did not secure it, since the harpoon-line parted. Our position at this time was lat. 37° 48′ N., long. 74° 38′ W.

Not long after the school of porpoises passed us, and while supper was being served, the vessel ran into a school of fish which, in the opinion of the second officer, who was in charge of the deck at the time, were mackerel, judging from their characteristic rush when disturbed. (Position, lat. 37° 44′ N., long. 74° 38′ W.) The large and small towing-nets were put out and towed for an hour at 6.05 p. m. A number of small jelly-fishes were taken in the small net and one young hake in the larger one. The position of this trial was lat. 37° 49′ N., long. 74° 36′ W.

It was my intention to set gill-nets during the night, but the condition of the water was favorable for noting any schools of fish that might be in the vicinity. In view of this fact and the importance of utilizing the night as well as day to cruise over as large an area as possible in order to observe the movements of surface-swimming fishes, I concluded to keep the vessel under way. Towards midnight a few dog-fish were seen from the mast-head, but no other fish were noticed. During the night our course was to the northeast, with the wind from east-southeast, and occasional showers of rain. The wind fell about midnight and a calm prevailed.

In the early morning of the 15th there was a calm, followed by a light variable wind, which, later in the forenoon, settled to a strong breeze from north-northwest. In lat. 38° 18′ N., long. 74° 14′ W., used the surface towing-net and collected a small quantity of sea-fleas. At 9 o'clock noticed a small flock of sea-geese in lat. 38° 18′ N., long. 74° 14′ W. Observations taken at noon showed our position to be 38° 18′ north latitude and 74° 14′ west longitude.

Tacked ship to the westward at 4 o'clock, and at 6.30 p. m. used the large and small towing-nets for an hour, collecting a lot of minute crustacea in the small net and one small hake in the larger net. (Position, lat. 38° 37′ N., long. 74° 10′ W.) The wind decreased considerably in force at 7 o'clock, and at 9 p. m. the vessel was hove-to and mackerel and herring gill-nets were set.

Hauled the nets at 4.30 a. m. on the 16th and caught 4 silver hake (*Merlucius*) about 13 inches long. As soon as the nets were on board got under way and stood to the west-northwest. Towed the large and small surface nets for a short time at 6.30 a. m., taking in them some small crustacea and two young hake. (Position, lat. 38° 37′ N., long. 74° 18′ W.)

Sighted pilot boat number 3, of Philadelphia, at 7.25 and changed course to intercept her, which we did at 8.20 a. m. Her captain reported not having seen any mackerel this season. After speaking with the pilot boat, the vessel was kept off to the northeast for 40 miles, with a lookout at the mast-head. Hove-to at 1 p. m. in lat. 39° 15′ N., long. 73° 48′ W., and threw toll-bait for thirty minutes, also tried for bottom fish with hand-lines, but got nothing. After completing the trial we got under way and towed the small surface net, collecting a limited amount of crustacea. The vessel was then headed on an east by north course, in which direction we sailed 19 miles, when we again put out the small surface net, in which nothing was taken. (Position, lat. 39° 20′ N., long. 73° 25′ W.)

At 4.30 p. m. the vessel was headed to the northeast, and about 5.40 p. m. we spoke with the British schooner *Atwood*, of Annapolis, Nova Scotia. Her captain reported seeing a large body of schooling fish the previous night, which he thought were mackerel, about 30 miles east-northeast of this position. With a view of finding these mackerel if possible, the *Grampus* was headed northeast by east one-half east, and we ran in that direction for 32 miles. At 11.15 p. m. tacked ship and lay-to. Put out the small surface towing-net for 30 minutes, in which were collected an abundance of the same species of crustacea as was found off Body Island. It is worthy of remark that this form of crustacean was not found in abundance in any other regions traversed to this time. (Position, lat. 36° 31′ N., long. 72° 50′ W.)

In the early morning of the 17th there was a strong breeze from north-northwest, with a sharp sea. At 2 o'clock tacked ship and lay-by on the port tack. The small towing-net was used at 9.15, but the weather was unfavorable for such work and the trial was very unsatisfactory. A trial with toll-bait was made at 1.25 p. m.; nothing was taken. Position, lat. 39° 35′ N., long. 72° 48′ W.

The vessel was kept off on a northeast course until 4.30 p. m., when the small towing-net was put out and took a large collection of crustacea, our position at this time being lat. 39° 42′ N., long. 72° 37′ W. Completing this trial we headed to the northeast and sailed in that direction for 11½ miles, when both the large and small towing-nets were put out, in which were collected an abundance of crustacea and 12 young hake. (Position, lat. 39° 52′ N., long. 72° 30′ W.) Hove-to at 11 p. m., and set large mackerel net.

The mackerel net was hauled at 4.45 a. m. on the 18th, taking nothing. Got under way at 5 o'clock and ran to the eastward for 11 miles. The small surface net was put out at 8 o'clock and collected a quantity of crustacea and one young pollock. At the same time took bottom temperatures in 45 fathoms of water. The position of this trial was lat. 30° 56′ N., long. 72° 12′ W.

The course was changed to northwest by north at 8.35 a m. When in lat. 40° 08′ N., long. 72° 30′ the small towing-net was put out and col-

lected an abundance of sea-fleas and one young hake. Used the small surface net again at 4.45 p. m. in lat. 40° 20′ N., long. 72° 47′ W., and took a small amount of crustacea. After completing the towing, sounded in 27 fathoms and took bottom temperature. (Position, lat. 40° 21′ N., long. 72° 47′ 30″ W.) About this time changed course to the eastward. Towards evening the wind increased, coming from south-southeast, with threatening weather and rain. At 7.45 p. m., hauled the jibs to windward and "jogged" on the starboard tack, and at 8.30 p. m., drew away jibs and "jogged" with mainsheet eased off. Tacked ship at 10 o'clock, heading to the southward, on port tack.

There was a stiff to moderate east-southeast breeze with foggy weather in the early part of the morning of the 19th. At 6 o'clock towed the small surface net for forty-five minutes and secured a few sea-fleas. (Position, lat. 40° 13′ N., long. 72° 19′ W.) The fog prevailed the greater part of the forenoon, with a moderate north by west wind; vessel on the port tack headed to northeast by north. During the afternoon the wind hauled from north-northwest to north-northeast; weather partially clear at intervals. At 4.30 p. m. a large school of porpoises came alongside, from which we harpooned and obtained one specimen. Used the small towing-net at this position, taking considerable crustacea. (Position, lat. 40° 38′ N., long. 71° 49′ W.) Also took bottom temperatures in the above position. Threw toll-bait for thirty minutes at 5.45 p. m., but did not "raise" any fish; also put out hand-lines for bottom fish with no better success. The easterly course was continued during the night.

On the morning of the 20th of May there was a moderate breeze from north-northwest, and clouded sky. At 6 o'clock Block Island bore abeam and a course was shaped for a point between Brenton's Reef and Sakonnet River, in which locality large numbers of floating fish eggs occurred last year. At 8.10 a. m., between the above mentioned places and about 4 miles off shore, the small surface net was towed for twenty minutes, in which were collected a large quantity of crustacea and some fish eggs. Frequent towings were made until 11 o'clock which resulted in the procurement of considerable quantities of fish eggs. Unfortunately, when jibing the main-boom the tackle overturned the dish containing the fish eggs, which occasioned the loss of the entire lot. However, the loss by this accident was repaired, since we made additional collections soon after. Some of the eggs thus obtained were put into the apparatus for developing eggs, and others were put into pans and the ova were kept alive by frequently changing the water on them. After making these collections we filled away for Wood's Holl, where we arrived at 4.35 p. m., and soon thereafter transferred the eggs to the hatchery.

The vessel laid at the Wood's Holl Station from the evening of the 20th until the morning of the 28th, the crew being employed in knitting together the several sections of the purse-seine and getting it ready for use, overhauling the seine-boat, etc.

On May 23d the Commissioner directed that the ship's writer, Mr. A. B. Alexander, be detached from the vessel and ordered to Gloucester, Mass., to await orders, and on the 25th Mr. Alexander left the vessel. Mr. George A. Miller, who was appointed to the position vacated by Mr. Alexander, reported for duty on the 1st of June.

I.—CHANGE OF COMMANDING OFFICER AND IN PERSONNEL.

On the 25th of May the Commissioner ordered me to assume full command of the vessel, in place of Capt. J. W. Collins, who had been assigned more important duties, and promoted Mr. E. E. Hahn to the position of first mate.

J.—CRUISE FOR LIVE MACKEREL.

The purse-seine and seine-boat, having been made ready and transferred to the vessel, we got under way at 9.12 a. m. on the 28th for the purpose of cruising at sea to secure, if possible, a school of spawning mackerel for the Wood's Holl Station, with a view to obtaining the eggs of that species for hatching mackerel fry. At 11.20 a. m., Gay Head bore abeam and our course was laid south by west one-half south. I had intended to cruise to the southward, in the vicinity of Cox's Ledge, judging that locality to be a good one for mackerel, but the threatening appearance of the weather and the increasing southeast wind induced me to run in the direction of Newport. During the early afternoon heavy rain showers prevailed, with an increasing southeast wind, attended by other indications of a stormy night. With such unfavorable conditions in view, I concluded it was best to run into Newport Harbor for the night, and at 4.57 p. m., we anchored between Fort Adams and Lime Rock Light.

The wind continued from the southeast in the early part of the 29th, though moderate in force, with a thick fog. The purse-seine was put into the seine-boat in the morning and the purse-line rove so that the apparatus would be ready for immediate use. The fog lifted about 1 o'clock and soon after we got under way. At 2 p. m., Brenton's Reef Light Ship bore abeam and the vessel was headed south on the starboard tack. The small surface net was put out at 6.20 p. m., in lat. 41° 02′ N., long. 71° 08′ W., and towed for forty minutes; a small collection of crustacea and young hake were obtained. At 7.40 p. m., hove-to for the night.

There was a south-southwest to southwest wind on the morning of the 30th, with squally weather until about 7.30 a. m. The small surface net was towed at 6.30 a. m., and in it was taken an abundance of the crustacean known to the fishermen as "red cayenne," or "seed," together with two young fish. Got under way and stood to the south-southwest at 6.33 a. m. The small towing-net was put out at 11.10 o'clock and secured one small fish. (Position, lat. 40° 45′ N., long. 71° 08′ W.) A

little later tacked ship to the east-northeast. The presence of surface fish-food and other indications of mackerel that were noticed this morning induced me to run back to look for fish in that direction, and also to continue the research farther to the southeast. At 1.53 p. m., put out the small surface net for fifteen minutes and collected six young fish and a few fish eggs.

Between 2 and 3.15 p. m. five towings were made with the small surface net, extending from lat. 40° 46′ N., long. 71° 00′ W., to lat. 40° 47′ N., long. 71° 55′ W. Near the last position an abundance of the red crustacean and small fish were taken in the net. Hove-to and threw "toll-bait" for mackerel, and also used hand-lines baited with alewives for bottom fish. This trial resulted in securing 2 squirrel hake, 6 common hake, and 1 female spiny-backed dog-fish, with young.

The vessel was kept hove-to until 9.25 p. m., when we got under way and stood to the east by north. Between 10 and 11 o'clock, from lat. 40° 47′ N., long. 70° 52′ W., to lat. 40° 50′ N., long. 70° 46′ W., we passed about twenty schools of fish, their presence being visible by the phosphorescence of the water. Most of these schools were small in size and deep down in water, several of them being startled by the vessel running through them. From their movements when disturbed we judged they were mackerel. I was anxious to set the purse-seine for some of these fish to determine the species, as well as to obtain some eggs for the hatchery, but the nature of the weather, a dense fog having set in, convinced me that an attempt at night seining could not have been successfully accomplished, with the small complement of men which we carried, without too much risk, since only one man could be left on board to work the vessel. At 11 o'clock the vessel was hove to for the night on the starboard tack.

In the early morning of the 31st there was a moderate south-southwest to south breeze, with foggy weather. At 6.30 a. m., in lat. 40° 47′ N., long. 70° 39′ W., put out hand-lines, baited with alewives, for bottom fish, and succeeded in catching 6 codfish, 2 common hake, and 1 haddock. The stomachs of the cod were opened and the contents examined. In them we found scallops, shrimp, and squid. Got under way on a northeast by east one-half east course at 8.24 a. m., and towed the small surface net on two occasions, which took an abundance of crustacea in each trial. (Position, lat. 40° 45′ 30″ N., long. 70° 36′ W., and lat. 40° 45′ N., long. 70° 35′ 30″ W., D. R.).

Between lat. 40° 46′ N., long. 70° 33′ W., and lat. 40° 45′ 30″ N., long. 70° 29′ W., from 10.45 to 11.30 a. m., three towings with the small surface net were made. Young hake, fish eggs, and "red seed" were collected. From the scant amount of the latter I judged we had reached the eastern limit of its distribution. Tacked ship at 11.30 and steered southwest, the object of this course being to locate the limits of the "red cayenne." Towings were made between 12.20 and 1.40 p. m. from lat. 40° 45′ N., long. 70° 29′ W., and lat. 40° 44′ N., long. 70° 32′ W. The

red crustacean was found very abundant in the last position. Two towings to the northeast of the last position failed to collect specimens of this form, but secured young hake and fish eggs.

During the day three hagdons and one jaeger were shot, though the birds were by no means numerous. At 5.35 p. m. a porpoise was harpooned by the second officer, and we succeeded in taking it on board. It is probably worthy of remark that this porpoise and its mate were in company with a school of blackfish. (Position, lat. 40° 43′ N., long. 70° 32′ W.) Towings with the small surface net in this position gave an abundance of the red crustacean, together with small round jellyfishes. The vessel was hove-to on the port tack at 7 o'clock.

In the early part of the following day (June 1) the wind was from the south, gradually hauling to the north-northwest, and then backing to the southwest in the afternoon, the weather being rainy and foggy. At 12.10 a. m. changed course to northwest one-half north, in which direction we sailed 21 miles, when the vessel was headed north-northwest for a distance of 2 miles, when our course was changed to north by east.

The small surface net was towed for twenty minutes at 9.05 a. m., in lat. 41° 07′ N., long. 71° 02′ 30″ W. (D. R.), and quantities of floating fish eggs, small crustaceans, and a few young fish were collected. At 10.35 the small towing-net was used; it took an abundance of fish eggs, which were put into the hatching apparatus. About 16 miles south-southwest from Vineyard Sound Light-Ship masses of floating fish eggs were collected, the tide probably bringing them together at this point. The fog cleared about 2 o'clock in the afternoon and the vessel was steered northeast by east. At 4 p. m. Gay Head bore abeam, and at 6.30 we ran into Wood's Holl Harbor and transferred the fish eggs to the hatchery.

K.—ORDERS FOR CONTINUING THE CRUISE.

After our arrival I received the following orders from the Commissioner, expressing his desire to have the work continued:

U. S. COMMISSION OF FISH AND FISHERIES,
Washington, D. C., May 30, 1888.

SIR: You will continue cruising for the purpose of taking live mackerel for the Wood's Holl hatchery, and making observations and studies of the movements of mackerel, etc., until further orders. Should you succeed in bringing in a lot of live mackerel, please telegraph the fact. At present it looks as though it may be desirable to continue your cruise until near the close of June, but we shall be governed largely by the results obtained.

Very respectfully,

M. MCDONALD,
Commissioner.

Capt. D. E. COLLINS,
Schooner Grampus, Wood's Holl, Mass.

L.—NARRATIVE OF CRUISE FROM JUNE 4 TO 30.

The vessel laid at Wood's Holl until June 4, the intervening period being occupied in routine work. The porpoise was shipped in ice by express to the U. S. National Museum, Washington, D. C., on the 2d.

We got under way at 1.20 p. m. on the 4th, and were towed to the entrance of the harbor by the steam-launch belonging to the station. Beat down the sound with a very light wind, and at 4 p. m. anchored in Tarpaulin Cove. The small surface net took a quantity of crustacea which resembled larval crabs. Terns were numerous and evidently had found some kind of food in the water. A school of fish was noticed inside the buoy off the point of the harbor, but it was, of course, impossible to secure it. The surface net was put out at 6.30 p. m., and took some small crustaceans.

Got under way at 5 a. m. on the 5th, with a light westerly breeze and strong head tide, and beat out of the Sound. At 8.10 put out the surface towing-net and took a great quantity of small copepods. It may be interesting to state that the copepods were noticed at the surface of the water in long streaks.

Spoke with the fishing schooner *James Dyer* about 7 miles southwest of No-Man's Land. Her captain reported not having seen any schooling mackerel, but that a few schools had been taken in this vicinity on the 3d. I learned later that the captain was mistaken in regard to the species, since it was reported to me that several schools of alewives were caught, but no mackerel.

After speaking with the *Dyer* the *Grampus* was headed southeast by south one-half south, in which direction we sailed 32 miles. The surface net was towed at this point and took a small quantity of crustacea, some fish eggs, 2 young hake, 2 specimens of another species of fish, and two jelly-fishes. (Position, lat. 40° 47′ N., long. 70° 29′ W.) In this position a small school of fish was noticed and an attempt was made to capture them, but before the seine was in position they had sunk deep below the surface. After this attempt we continued on our southeast course under shortened sail. At 8 p. m. some porpoises were seen.

The vessel was hove-to from midnight until 5 a. m. on the next day. At 5 o'clock the small surface net was put out and collected an abundance of crustacea in fifteen minutes. (Position, lat. 40° 27′ N., long. 70° 01′ W.) Got under way at 5.15 a. m., steering east-southeast, in which direction we sailed 10 miles. The small towing-net was put out in lat. 40° 26′ N., long. 69° 49′ W., but collected nothing. Tacked ship at 7.25 a. m. and stood to the west-northwest for 3 miles and then to the north for 10 miles. The small surface net was towed for 25 minutes at 10 o'clock, but took nothing. (Lat. 40° 36′ N., long. 69° 55′ W.)

We spoke with the schooner *Nellie M. Rowe*, of Gloucester, soon after making the last trial, and, in an interview with her captain, learned

that they had been searching for mackerel for the past week, but, so far, had not succeeded in getting any. On the 4th instant they took a school of menhaden about east by north 20 to 25 miles from Barnegat. Finishing our interview with the captain of the *Rowe*, we steered a course to the south-southeast, in which direction we sailed a distance of 13 miles. At 1.45 p. m. the small surface net was put out, in which we took nothing. (Position, lat. 40° 27′ N., long. 69° 47′ W.) We then tacked and stood to the west by north, and ran a distance of 13½ miles. At 3.53 p. m. used the small surface-net in lat. 40° 29′ N., long. 70° 04′ W., and obtained an abundance of the red crustacean. Our next course was west, in which direction we sailed a distance of 4 miles, when we tacked to south-southeast. At 6.20 p. m., in lat. 40° 22′ N., long. 70° 04′ W., put out the small surface towing-net for twenty minutes, and took the largest quantity of the red crustacean yet obtained. The wind increased to a very fresh breeze with a sharp sea, which was unfavorable for noting the presence of schooling fish at any distance from the vessel, unless they should "show up" very plainly at the surface. At dark the vessel was hove-to on the port-tack.

In the early part of the next day (June 7) there was a stiff breeze from south-southwest, with cloudy weather. At 4.40 a. m. sounded in 48 fathoms of water and took bottom temperature; put out the small surface-net, in which were collected a lot of sea-fleas and other crustacea. (Position, lat. 40° 13′ N., long. 69° 58′ W.) At 6.40 a. m. kept off to the northwest by north, on which course black hagdons were seen at intervals. The small towing-net was put out at 3 o'clock and collected some fish eggs and two young fish. (Position, lat. 40° 57′ N., long. 71° 03′ W.) At 3.20 p. m. sounded in 26 fathoms of water and took bottom temperature. At 3.30 changed course to north-northeast one-half east, and in a few minutes steered to the northeast.

We spoke with the fishing schooner *Elisha Baker*, fishing for cod-fish on Cox's Ledge. Her captain reported not having seen any schooling fish, but that several mackerel vessels had recently been in this vicinity. He gave us the head of a large mackerel which he had taken from his trawl-line, and he supposed that sharks had eaten the body.

After speaking with the *Baker* we changed our course and steered north-northwest one-half west. The small surface net was towed between 6 and 7.30 o'clock, and in it was obtained a large quantity of fish eggs, copepods, and other small crustacea, our position being about 8 or 10 miles southeast from Block Island. About dark the captain of the schooner *Stowell Sherman*, of Provincetown, boarded us to learn news about mackerel. We furnished him with what information we had, and in return learned that he had been cruising for mackerel since June 2, covering a region between Shinnecock and South Shoal Light-ship, but in the whole of the cruise had not seen any schooling fish. He also said that several weirs at Truro had caught mackerel just previous to his departure from port. We hove-to for the night at 7 o'clock.

There was a stiff to fresh breeze from northeast by east in the early morning of the 8th, with a sharp sea, the weather being misty and rainy. The vessel was "jogging" from 12.30 a. m. until daybreak, when the sheets were trimmed and we stood inshore towards Newport. Anchored in Newport Harbor at 9 o'clock, where we found four or five fishing vessels. Other mackerel schooners arrived during the day until late in the afternoon, when there were twenty-seven sail of fishing vessels in the harbor. Some of the captains visited us for the purpose of learning what news we had of mackerel, and they were informed of the results of our investigation. Their reports acquainted me with the recent catches of mackerel by the vessels of the fleet.

The captain of the *Robert Pettis* reported that the schooner *Active* took 1,500 large mackerel on June 4 about 5 miles southwest of Block Island. Also, that four barrels of salt mackerel were taken by the schooner *Colonel French*, and one barrel by a Portland schooner in the same locality. Mackerel were seen off Cox's Ledge on the 3d, and some of the later arrivals in the harbor reported that mackerel were seen in the vicinity of Montauk Point.

On account of a calm we lay at anchor in Newport Harbor until 8.30 o'clock on the 9th, when we got under way, in company with other fishing vessels, with a light southerly breeze. At 10.15 Brenton's Reef Light-ship bore abeam, the fishing vessels working towards Block Island.

It may not be out of place to mention here that when we left Newport Harbor most of the fishing vessels were outside of the harbor, where they took advantage of the breeze as soon as it came along, which gave them a start of 4 or 5 miles of us, and when we were off Brenton's Reef Light-ship they still had a lead of 4 or 5 miles dead to windward of us. We gained quite rapidly on the fleet and at 4 p. m. our vessel was to the windward of them all, with the exception of the schooner *I. J. Merritt, jr.*, of Gloucester, and another schooner hailing from Wellfleet.

At 4.30 o'clock, when about 5 miles south by east from Block Island, we hove-to and spoke with the fishing schooner *Elizabeth Smith*, of Portland, Me., her captain desiring information in reference to mackerel, which was furnished him. The captain reported having sailed 30 miles to the southward of this position, but had seen no schooling fish. The purse-seine was transferred to the seine-boat, and at 6.40 p. m. we kept off on a southeast course, with four or five vessels of the mackerel fleet in company. We hove-to for the night at 7.45 p. m.

The fishing schooner *Gertrude Summers*, of Provincetown, made inquiries of us concerning mackerel in the early morning of the 10th. From her captain I learned that he had been along the south side of Long Island, where he saw schooling menhaden, but no mackerel.

Got under way, steering east-northeast, at 9.55 a. m., with cloudy and foggy weather; changed course to north at 10.15 a. m., and steered to the westward at 10.50. The schooner *C. A. Sanford*, of Dennis, spoke

with us at 11.10. She had cruised as far as 40 miles south-southwest of Fire Island. Saw menhaden, but no mackerel.

When about 5 miles south by east from Block Island, at 1.50 p. m., put out hand-lines for bottom fish, and in an hour caught five cod-fish and eighteen cunners. The fog cleared at 4.45 p. m., when we laid a course for Block Island and came to anchor on the northeast side of the island at 5.35 o'clock, where also were twenty-three sail of mackerel schooners. At the time of anchoring the wind was fresh from south-southwest, with threatening weather.

We laid at anchor off Block Island during the 11th, the fresh south-southwest wind continuing, accompanied by foggy weather until 6 a. m., and low barometer. I visited the schooner *Jennie Seaverns*, of Gloucester, in the afternoon. From her captain I learned that on the previous day he cruised 60 miles southeast of Block Island, during which he saw several schools of herring. He said that the schooner *David F. Low*, of Gloucester, caught 60 barrels of small mackerel on the 4th, about 35 miles from Fire Island. These fish were marketed in New York, but they brought a low price, on account of their small size. The captain of the *Low* reported that small mackerel were numerous in that locality at the time. I also learned that two or three small schools of large mackerel had been seen near Shinnecock recently.

At 4 o'clock on the morning of the 12th got under way on the port tack, steering to the southward, in company with the whole mackerel fleet. When about 3 miles southeast from Block Island Light changed course to south-southwest. We ran into numerous schools of fish about 5 miles southeast of Block Island, which had the appearance of menhaden. At 6 a. m. left the vessel, in the seine-boat, to set the purse-seine around a school of fish, but on finding them to be menhaden did not shoot it. It was noticed that none of the fleet succeeded in getting any fish, although several of them set their seines. Menhaden steamers were seen inshore, to the westward of Montauk Point. At 10.55 a. m. there were numerous schools of menhaden in sight, all of which seemed to be moving to the eastward. Made another trial with the purse-seine, but did not succeed in getting fish. After this trial we stood off-shore on a south-southeast course, the wind having veered round to the southwest. We sailed in this direction for 20 miles and occasionally passed schools of menhaden. At 5.40 p. m. we saw several schools of fish which appeared to be mackerel, and captured a school containing about six barrels, in the purse-seine, about 6 o'clock. Upon examination, the largest were found to be only 8 inches in length and were not spawning fish. We saved about a barrel of them and liberated the rest. These fish were captured in lat. 40° 36′ N. long. 72° 00′ W. It was noticed that the vessels of the fleet, which were to the southward and westward of us, were apparently among the fish, though it is impossible to say whether they took any. Near the position where the small mackerel were caught the small surface net was used and in it

we collected a very limited amount of crustacea. In the position of the first set of the seine this morning a species of crustacea was very abundant. The vessel was hove-to at dark, with jibs to windward.

There was a moderate breeze from the southwest with clear weather on the morning of the 13th. Got under way at 5.40 a. m. and stood to the westward until 8 o'clock, at which time we tacked ship and ran to the southward. At 10.45 tacked ship and "jogged," while bottom temperatures were taken. Spoke with the schooner *Carl Schurz*, the captain reporting that he had been cruising off Fire Island, but saw nothing but small mackerel and menhaden. The surface net was put out at 11.35 and secured a small amount of crustacea. The schooner *F. A. Lambert*, of Cohasset, was spoken at 12.30 p. m.; the captain reported having taken some small mackerel on the previous day, but had seen none since. A large school of porpoises passed us at this time.

We continued on the southerly course until 3.20 p. m., when a school of mackerel was seen and we succeeded in capturing it. The school contained about 14 barrels of "tinkers" about the same size as those taken yesterday, and we turned them loose. (Position, lat. 40° 25′ N., long. 72° 28′ W., D. R.). After making this trial the vessel was steered on a northeast course. It was noticed that the schooner *George A. Leland* made a haul of fish, and soon after we got under way and spoke with her, learning that the fish were all small. During the afternoon numerous schools of these small fish were passed; as the fish were well up at the surface it was an easy matter to determine their size and species. At 8.30 p. m. changed course to northeast by east, and at 9 o'clock Shinnecock Light bore abeam, at which time the vessel was headed to the east-northeast.

The morning of the 14th opened with a moderate southerly wind and clear weather. At 5 o'clock Montauk Point bore northwest about 6 miles distant. There were five fishing vessels near us steering to the eastward, and the rest of the fleet in sight to the southeast, about 8 or 9 miles. Changed course and steered towards this last lot of vessels, and soon after it was noticed that three of them had taken fish. We ran up to the *Mertie and Delmar*, of Chatham, and boarded her. The captain reported having taken 50 barrels of small mackerel the afternoon before, and at the time we went on board the crew were engaged in dressing them. No large mackerel had been seen by him. The position of the catch of the *Delmar* was about 12 miles south-southeast from Block Island. At 9.30 o'clock a. m. we kept off and ran to the northeast by east. Put out the small surface net at 11.20, when about 4 miles northwest one-half north from Cox's Ledge; towed it for twenty-five minutes and collected a small amount of fish eggs.

After completing this towing the *Grampus* was kept-off on a northeast course. The towing-net was again put out at 12.45 p. m. and took a small amount of fish eggs in five minutes. At 1.40 o'clock the same apparatus was towed for 10 minutes; two young fish and some fish eggs

were collected. At 2.30 p. m. Gay Head bore abeam, and a little later we spoke with the schooner *Lizzie Maud*, of Portland, off Manemsha Bight. Her captain reported getting 800 large mackerel in this locality the day before. We hove-to off Manemsha Bight to look for mackerel, and saw one school containing probably a barrel, which, however, sunk out of sight before we had an opportunity to attempt a capture. Later in the afternoon the wind increased to a fresh breeze, accompanied by rain squalls, and the vessel was headed for Wood's Holl, where we arrived about dark.

Dr. T. H. Bean left the vessel on the 15th and proceeded to Gloucester, in compliance with instructions from the Commissioner. The Commissioner visited the vessel during the afternoon and made arrangements to have the crew assist in preparing a shipment of live lobsters for the West Coast. After completing this work, the purse-seine was prepared for storing, and, together with other apparatus taken on board at the beginning of the cruise, was transferred to the store-house at this station, in accordance with verbal instructions from the Commissioner. Completing the storing of the apparatus, the vessel sailed for Gloucester, Mass., on the 18th, where we arrived the next day. From the 19th of June until the end of the fiscal year the vessel laid at Gloucester painting and refitting for her summer's work.

On account of failing health I was granted leave of absence from the 24th of June until the vessel was fitted for sea, the repairs being under the direct supervision of the first officer, Mr. E. E. Hahn.

The following tabulated statements present in a concise form the results of the work performed on the cruise:

M.—TABULATED STATEMENTS.

TABLE 1.—*Showing towings with small surface-net.*

Date.	Hour.		Position.		Time occupied.	Distance towed.	Results
	A. M.	P. M.	Lat. N.	Long. W.			
1888.			° ′ ″	° ′ ″		*Miles.*	
Apr. 17	11	....	36 50	75 45	45 minutes..	2	Nothing.
17	....	3	36 45	75 27	30 minutes..	1½	Do.
17	....	7	36 36	75 13	....do	1½	Miscellaneous forms of crustaceans.
18	7	....	36 13	74 51	1 hour	3	Do.
18	....	6.30	35 46	74 55	½ hour	1½	Do.
19	7	....	35 48	74 43	....	....	Do.
19	10	....	....	....	....	....	Do.
19	....	4	36 34	74 34	....	....	Do.
20	8	....	....	....	1½ hours	3½	Nothing.
20	....	6	37 03	74 49	....	....	Miscellaneous forms of crustaceans.
21	....	4.30	37 07	74 48	40 minutes..	....	Do.
22	6	....	....	....	1½ hours	2	Do.
22	9.40	....	....	....	30 minutes..	....	Do.
22	....	6	37 35	74 39 30	....do	1	Do.
23	6.30	....	37 40	74 30	....do	1	Do.
May 1	7	....	36 43 30	74 47 30	....do	1	Do.
1	11	....	36 58	74 26	....do	1	Do.
1	....	2.30	36 59	74 32	....do	1	Do.
1	....	4	37 00	74 40	....do	1	Do.
1	....	6	36 59 45	74 46	....do	1	Nothing.

TABLE 1.—*Showing towings with small surface-net*—Continued.

Date.	Hour.		Position.		Time occupied.	Distance towed.	Results.
	A. M.	P. M.	Lat. N.	Long. W.			
1888.			° ′ ″	° ′ ″		*Miles.*	
May 2	6.30	....	36 53	74 40	30 minutes..	1	Miscellaneous forms of crustaceans.
2	....	2.43	37 01 30	75 00	....do	1	Do.
2	....	6.25	37 06	74 47	20 minutes..	¾	Do.
3	6	....	36 58	74 51	1 hour	2	Do.
3	11	....	36 59	74 50	30 minutes..	1	Do.
3	....	6.10	37 09	74 47	45 minutes..	1½	Do.
4	10	....	37 24	74 49	30 minutes..	1	Do.
4	....	2	37 07	74 07	....do	1	Do.
5	6.20	....	36 59	75 02	40 minutes..	1	Do.
5	9.15	....	37 04	75 16	30 minutes..	1	Do.
5	10.30	....	37 02	75 33	....do	1	Do.
12	....	1	37 00	75 32	20 minutes..	1	Do.
12	....	4	37 02	75 01	30 minutes..	1	Do.
12	....	6	37 03	74 47	60 minutes..	2	Miscellaneous forms of crustaceans and jelly-fishes.
13	6	....	36 59	74 41	....do	2	Green fish eggs.
13	9.30	....	37 00	74 40	1½ hours	3	Do.
13	....	4.30	37 15	74 48	30 minutes..	1	Miscellaneous forms of crustaceans.
13	....	6.30	37 22	74 53	50 minutes..	1½	Do.
14	5	....	37 16	74 50	60 minutes..	1½	Miscellaneous forms of crustaceans and mollusca.
14	7	....	37 18	74 48 30	....do	1½	Miscellaneous forms of crustaceans.
14	....	6	37 49	74 36	....do	1½	Do.
15	6	....	38 18	74 14	30 minutes..	1	Do.
15	....	6.30	38 37	74 10	60 minutes..	2	Do.
16	6.20	....	38 37	74 18	30 minutes..	1	Do.
16	....	1	39 15	73 48	....do	1	Do.
16	....	4.05	39 20	73 25	....do	1	Nothing.
16	....	11.15	39 31 30	72 50	....do	1	Crustaceans.
17	9.15	....	39 31	72 50	....do	1	Nothing, weather bad.
17	....	4.30	39 42	72 37	25 minutes..	1	Miscellaneous forms of crustaceans.
17	....	6.45	39 52	72 30	50 minutes..	1½	Crustaceans and 1 small pollock.
18	8	....	39 56	72 12	30 minutes..	1	Crustaceans and 1 small hake.
18	....	1.30	40 08	72 30	60 minutes..	2	Crustaceans.
18	....	4.45	40 20	72 47	30 minutes..	1	Do.
18	....	7	40 23	72 26	....do	1	Do.
19	6	....	40 13	72 19	45 minutes..	1½	Do.
19	....	5.45	40 38	71 49	30 minutes..	1	Do.
29	....	6.20	41 02	71 08	40 minutes..	1½	Crustaceans and 2 young hake.
30	6.30	....	40 51	70 51	20 minutes..	¾	"Red Cayenne" and 2 young hake.
30	11.10	....	40 45	71 08	13 minutes..	¼	1 small fish.
30	....	1.53	40 46	71 00	15 minutes..	¼	Fish eggs and young fish.
30	....	2	40 47	71 55	75 minutes..	4	Crustaceans.
31	8.24	....	40 45 30	70 36	23 minutes..	½	Do.
31	10.05	....	40 45	70 35 30	....	....	Do.
31	10.45	....	40 46	70 33	45 minutes..	2	Crustaceans, hake, and fish eggs.
31	....	12.20	40 45	70 29	80 minutes..	....	Crustaceans.
31	....	5.35	40 43	70 32	....	....	"Red Cayenne" and jelly-fishes.
June 1	9.05	....	41 07	71 02 30	20 minutes..	¼	Crustaceans, fish eggs, and young fish.
1	10.35	....	....	....	....do	¼	Fish eggs.
4	....	4	Tarpaulin Cove ...		....	....	Crustaceans.
4	....	6	....do		....	....	Do.
5	8.10	....	....do		....	....	Do.
5	....	5.25	40 47	70 29	20 minutes..	....	Crustaceans, 2 small hake, and fish eggs.
6	5	....	40 27	70 01	15 minutes..	¼	Crustaceans.
6	7	....	40 26	69 49	10 minutes..	¼	Nothing.
6	10	....	40 36	69 55	25 minutes..	½	Do.
6	....	1.45	40 27	69 47	20 minutes..	¼	Do.
6	....	3.53	40 29	70 04	....do	⅜	"Red Cayenne" very abundant.
6	....	6.20	40 22	70 04	....do	⅜	Do.
7	4.40	....	40 13	69 58	10 minutes..	¼	Crustaceans.
7	....	3	40 57	71 03	....do	¼	Fish eggs and 2 young fish.
7	....	7	Off Block Island ..		90 minutes..	....	Fish eggs in abundance.
12	....	6	40 36	72 00	....	....	Crustaceans.
13	11.35	....	40 29	72 00	....	⅜	Do.
14	11.20	....	Off Cox's Ledge ...		30 minutes..	....	Fish eggs.
14	....	12.45	....do		5 minutes..	....	Do.
14	....	1.40	Off Gay Head.......		10 minutes..	....	Fish eggs and young fish.

TABLE 2.—*Showing towings with large surface-net.*

Date.	Hour.		Position.		Time occupied.	Distance towed.	Results.
	A. M.	P. M.	Lat. N.	Long. W.			
1888.			° ′ ″	° ′ ″		Miles.	
Apr. 18	....	6.30	35 46	74 55	30 minutes..	1½	5 young fish.
19	....	....	36 34	74 34	....	....	1 butterfish,
21	....	5	37 07	74 48	40 minutes..	1½	1 small fish.
22	....	6	37 35	74 39 30	30 minutes..	1	Nothing.
23	6.30	....	37 40 30	74 30 00	... do	1	Do.
May 1	....	6	36 59 45	74 46	....do	1	Do.
2	....	6.25	37 06	74 46	20 minutes..	1	Do.
3	....	6.10	37 09	74 47	45 minutes..	2	1 butterfish and 1 small hake.
13	....	6.30	37 22	74 53	50 minutes..	2	Nothing.
14	....	6	37 49	74 36	60 minutes..	2	1 small hake.
15	....	6.30	38 37	74 10	60 minutes..	2	1 small hake.
16	6.20	....	38 37	74 18	30 minutes..	1	2 small hake.
17	....	6.45	39 52	72 30	50 minutes..	1½	12 small hake.

TABLE 3.—*Showing trials for fish with "toll-bait," hand-lines, etc.*

Date.	Hour.		Position.		Apparatus.	Bait.	Time occupied.	Results.
	A. M.	P. M.	Lat. N.	Long. W.				
1888.			° ′ ″	° ′ ″				
April 18	8	....	36 13	74 51	Toll-bait....	Toll	30 minutes..	Nothing.
18	8	....	36 13	74 51	Hand-lines..	Salt fish ..	....do	1 dog-fish.
18	....	2.30	36 56	75 02	Toll-bait....	Toll	....do	Nothing.
18	....	2.30	36 56	75 02	Hand-lines..	Salt fish ..	....do	2 dog-fish.
19	3	....	35 48	74 43	Gill-nets....	Nets.......	2 hours	Nothing.
20	5	....	36 39	74 51	Toll-bait....	Toll	40 minutes..	Do.
20	5	....	36 39	74 51	Hand-lines..	Salt fish ..	....do	1 dog-fish.
21	....	4.30	37 07	74 48	Toll-bait....	Toll	50 minutes..	Nothing.
21	....	7	37 07	74 48	Gill-nets....	Nets.......	10 hours	1 small mackerel.
22	12 m.	....	37 22	74 47	Toll-bait....	Toll	1 hour	Nothing.
22	12 m.	....	37 22	74 47	Hand-lines..	Salt fish ..	....do	Do.
22	....	4.23	37 32	74 50	Toll-bait....	Toll	....do	Do.
23	6.30	....	37 40	74 30	....do	....do	30 minutes..	Do.
23	6.30	....	37 40	74 30	Hand-lines..	Salt fish ..	....do	Do.
24	10.30	....	37 39	74 38	Toll-bait....	Toll	50 minutes..	Do.
24	10.30	....	37 39	74 38	Hand-lines..	Salt fish ..	....do	1 dog-fish.
25	1	....	37 31 45	74 39	Gill-nets....	Nets.......	3 hours	1 Branch herring
May 1	10	....	36 56 30	74 21	Toll-bait....	Toll	30 minutes..	Nothing.
2	....	6.45	37 06	74 47	Gill-nets....	Nets.......	9 hours	Do.
3	....	3.25	37 07	74 51	Toll-bait....	Toll	2 hours	Schools of "Brit."
3	....	3.25	37 07	74 51	Hand-lines .	Salt fish ..	2 hours	Nothing.
3	....	7	37 09	74 47	Gill-nets....	Nets.......	9½ hours	1 butterfish.
4	9.15	....	37 24	74 49	Toll-bait....	Toll	30 minutes..	Nothing.
4	9.15	....	37 24	74 49	Hand-lines..	Salt fish ..	....do	Do.
5	6.20	....	36 59	75 02	Toll-bait....	Toll	40 minutes..	Do.
5	6.20	....	36 59	75 02	Hand-lines..	Salt fish ..	....do	2 dog-fish.
14	8.25	....	37 18	74 48 30	Toll-bait....	Toll	60 minutes..	Nothing.
14	8.25	....	37 18	74 48 30	Hand-lines..	Salt fish ..	....do	2 skates.
15	....	9	38 36 30	74 12	Gill-nets....	Nets.......	7½ hours	4 silver hake.
16	....	1	39 15	73 48	Toll-bait....	Tolling ...	30 minutes..	Nothing.
16	....	1	39 15	73 48	Hand-lines..	Salt fish ..	....do	Do.
17	....	1	39 35	72 48	Toll-bait....	Toll	50 minutes..	Do.
17	....	11	39 52	72 33	Gill-nets....	Nets.......	5.45 hours ..	Do.
18	....	....	40 38	71 49	Toll-bait....	Toll	30 minutes..	Do.
18	....	....	40 38	71 49	Hand-lines..	Salt fish ..	....do	Do.
30	....	3.35	40 47	71 55	Toll-bait....	Toll	....do	Do.
30	....	3.35	40 47	71 55	Hand-lines..	Salt fish ..	....do	6 common hake, 2 squirrel hake.
31	6.30	....	40 47	70 39	....do	Alewives .	1 hour	6 cod, 2 common hake, 1 haddock.
June 10	....	1.50	5 M. E. off Block I d		....do	....	....	5 cod, 18 cunners.
12	6	....	3 M. S. E. Block Id.		Purse-seine .	Seine	....do	Liberated fish.
12	8.40	....	4 M. off Montauk Pt		....do	....do	....do	Missed.
12	....	6	40 36	72 00	....do	....do	45 minutes..	6 barrels tinker mackerel.
13	....	3.20	40 25	72 28	....do	....do	40 minutes..	14 barrels tinker mackerel.

TABLE 4.—*Showing positions of occurrence of pelagic fishes, etc., spring of* 1888.

Date.	Hours. A. M.	Hours. P. M.	Position. Lat. N.	Position. Long. W.	Species.	Quantity.	Remarks.
			° ′ ″	° ′			
Apr. 9	......	8	37 27	74 48	Unknown.....	3 pods......	Seen from mast-head.
17	......	4	36 45	75 27	Whales......	3...........	Do.
20	6	......	36 39	74 51	Porpoises.....	School......	Going N. W.
May 3	......	3.25	37 07	74 51	"Brit"......	School......	Attracted by "toll-bait."
14	7	......	37 16	74 50	Unknown.....	3 schools....	At distance from vessel.
14	......	5	37 44 30	74 38	Porpoises.....	School......	Harpooned one specimen.
14	......	5.40	37 44 30	74 38	Mackerel.....	....do......	Encountered by vessel.
15	......	11	39 36	72 45	....do........	....do......	Reported by schooner *Atwood.*
19	......	4.30	40 38	71 49	Porpoises.....	....do......	Captured one specimen.
20	8	......	Off Brenton's Reef.		Fish eggs.....	250,000......	Between reef and Sakonnet River.
30	......	10	40 47	70 52	Schooling fish.	20 schools...	Between lat. 40° 47′ N. long. 70° 52′ and lat. 40° 50′, long. 70° 46′.
31	......	5.35	40 43	70 32	Porpoises.....	School......	With school of blackfish.
June 4	......	5	Tarpaulin Cove...		Mackerel.....	....do......	Inside harbor.
4	......	......	25 miles east of Barnegat.		Menhaden.....	....do......	Captured by *Nellie M. Rowe.*
4	......	......	Off Block Island...		Mackerel.....	1,500 large.	Captured by schooner *Active.*
4	......	......	....do..........		....do........	4 barrels....	Captured by schooner *Col. French.*
4	......	......	35 miles off Fire Island.		....do........	60 barrels...	Captured by schooner *David J. Low.*
5	......	......	Tarpaulin Cove...		Alewives.....	School......	Reported by schooner *James Dyer.*
5	......	5.25	40 47	70 29	Mackerel.....	....do......	Tried for, but "missed."
5	......	8	40 47	70 29	Porpoises.....	Several......	Seen from vessel.
6	......	......	Cox's Ledge......		Mackerel.....	Head of.....	On trawl-line.
12	6	......	3 m. SE. Block Id.		Menhaden.....	Schools.....	Seen from vessel.
12	8.40	......	4 m. off Montauk..		....do........	....do......	Do.
12	......	12.30	....		Porpoises.....	....do......	Passing to eastward.
13	......	3.20	40 25	72 28	Mackerel.....	....do......	Seen from vessel.
13	......	......	Manemsha Bight..		....do........	800 large....	Taken by schooner *Lizzie Maud.*
14	......	......	12 m. SSE. Block Id.		....do........	50 barrels...	Taken by schooner *Mertie and Delmar.*
14	......	......	Manemsha Bight..		....do........	School......	Seen from vessel.

TABLE 5.—*Showing temperatures of air, surface and bottom water, etc., from April* 17 *to June* 13, 1888.

Date.	Hour. A. M.	Hour. P. M.	Position. Lat. N.	Position. Long. W.	Depth (fathoms).	Character of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.
			° ′ ″	° ′ ″			°	°	°
Apr. 17	8	......	36 58 00	76 02 00	......	Mud..........	45	51	......
17	12 m	......	36 50 00	75 45 00	......	....do........	44	45	......
17	......	4	36 44 00	75 24 00	......	....do........	42	45	......
18	12 m	......	36 20 00	75 01 00	......	....do........	43	45	......
18	4	......	36 14 00	74 53 45	......	....do........	46	46	......
18	8	......	36 13 00	74 50 00	47	....do........	49	46	46
18	12 m	......	36 04 00	74 54 00	......	....	54	47	......
18	......	2.35	35 55 00	75 02 00	17	Mud..........	52	48	47.5
18	......	6	35 46 00	74 55 00	28	....do........	54	48.5	48
19	8.15	......	35 57 00	74 28 00	175	....do........	53	49	46
19	......	4	36 30 00	74 41 00	22	....do........	50	46.5	46
19	......	6.45	36 34 00	74 34 00	22	....	50	46.5	46
20	8	......	36 39 00	74 51 30	32	Mud..........	50	45	45
20	12 m	......	36 42 00	74 48 00	43	....do........	45	45	45
21	8	......	37 04 00	74 44 15	30	....do........	44	45	45.5
21	12 m	......	37 03 45	74 48 30	30	....do........	48	45	43.5
22	10	......	37 16 00	74 47 00	......	....	46	45	......
22	12 m	......	37 22 00	74 47 30	24½	Mud..........	48	45	43
22	......	4.33	37 32 00	74 50 00	21	....	50	45	43
23	7	......	37 40 30	74 30 00	38	Mud..........	45	45	43
24	10	......	37 29 00	74 35 30	34	....do........	46	47.5	43.5
24	......	6.15	37 31 45	74 39 00	31	....do........	46	46	43
25	......	3.30	Cape Henry......		......	....	46	52	......

TABLE 5.—*Showing temperature of air, surface and bottom water, etc.*—Continued.

Date.	Hour. A. M.	Hour. P. M.	Position. Lat. N.	Position. Long. W.	Depth (fathoms).	Character of bottom.	Temperatures. Air.	Temperatures. Surface.	Temperatures. Bottom.
			° ′ ″	° ′ ″			°	°	°
Apr. 25		7	Hampton Roads				43	52	
26	6		....do				44	52	
26	12 m		....do				52	54	
26		4	....do				52	54	
27	6		....do				48	53	
27	12 m		....do				60	53	
27		4	....do				60	54	
28	6		....do				52	54	
28	12 m		....do				55	54	
28		4	....do				55	56	
29	6		....do				55	56	
29	12 m		....do				60	56	
29		4	....do				65	56	
30	7		....do				63	57	
30		2	37 02 00	76 02 00	10	Mud	72	52.5	49
30		3	36 58 00	75 53 00	7	....do	66	54	49
30		4	36 57 45	75 42 00	8	....do	60	51.5	48
30		5	36 57 00	75 29 30	11½	....do	56	50	45
30		6	36 56 30	75 18 00	16	....do	55	48	44.5
30		7	36 56 00	75 07 30	23	....do	55	48	45
30		9	36 52 45	75 01 30	22	....do	54	47.5	44.3
30		12 m	36 49 30	74 56 30	23	....do	52	47.5	44.2
May 1	3		36 46 30	74 54 00	30	....do	53	48	44
1	7		36 43 30	74 47 30	49	....do	54	47.5	44.7
1	10		36 58 00	74 21 00	270	No bottom	55	50	42
1		12.30	36 58 00	74 27 00	320	....do	55	46	41
1		2.25	36 59 30	74 32 00	220		50	49	43.2
1		4	37 00 00	74 40 00	35	Muddy	50	49	45
2	1		36 55 00	74 49 00	30	....do	50	48	47
2	11		36 59 30	74 51 00	19	....do	48	48	
2		3	37 05 00	74 57 00	23	....do	49	48.5	47.3
2		4.45	37 05 00	74 57 00	23	....do	49	48.5	47.3
2		11	37 03 45	74 48 30	30	....do	46	48	45
3	5		36 58 00	75 04 00	27	....do	46	48	44
3	12 m		36 59 00	74 43 30	45	....do	49	48	45
3		3.25	37 07 00	74 51 00	30	....do	50	48	47
3		7	37 09 00	74 47 00	32	....do	47	47	43
4	9.15		37 24 00	74 49 00	25	....do	52	48	48.2
4		12.45	37 10 00	74 58 00	19½	....do	50	47	46
4		11	36 54 00	74 48 00	31	....do	51	48	43.8
5	3		36 52 30	74 54 00	22	....do	53	48	45.5
5	5		36 52 18	74 57 00	21	....do	58	48	47
5	7.20		36 59 00	75 02 00	21	....do	52	48	48
5	10.50		37 01 30	75 37 30	13	....do	55	48.5	48.5
5		3.30	Cape Henry				63	59	
5		8	Hampton Roads				60	60	
6	8		....do				60	59	
6	12 m		....do				65	62	
6		4	....do				65	62	
7	8		....do				60	60	
7	12 m		....do				65	65	
7		4	....do				65	62	
8	8		....do				65	63	
8	12 m		....do				70	63	
8		4	....do				70	62	
9	8		....do				65	62	
9	12 m		Chesapeake Bay				70	62	
9		4	....do				68	62	
10	8		....do				68	62	
10	12 m		....do				65	62	
10		4	....do				65	64	
11	8		Hampton Roads				68	64	
11	12 m		....do				69	64	
11		4	....do				69	65	
12		1	37 00 00	75 32 00	12½	Hard sand	65	59	49
12		4	37 02 00	74 01 30	20	....do	63	56	53
12		6	37 03 30	74 47 00	35	....do	60	56.5	44.5
12		12 m	36 59 00	74 43 00	55	....do	61	55	48.5
13	7.25		36 59 00	74 40 00	56	....do	56	56	48
13		6.30	37 22 30	74 55 00	26	....do	54	55	43
13		9			22	....do	55	55	N. S.
13		12 m			23	....do	55	56	N. S.
14	4		37 14 00	74 50 30	25	....do	55	56	48
14		12 m	38 00 30	74 26 00	25	....do	54	54	45
15	6.30		38 18 00	74 14 00	27	....do	50	53.5	44
15		4.22	38 37 37	74 10 00	21	....do	52	53	43
15		12 m	38 36 30	74 12 00	22	....do	50	52	45
16	4		38 36 30	74 10 00	25	....do	52	53	46

TABLE 5.—*Showing temperature of air, surface and bottom water, etc.*—Continued.

Date.	Hour.		Position.		Depth (fathoms).	Character of bottom.	Temperatures.		
	A. M.	P. M.	Lat. N.	Long. W.			Air.	Surface.	Bottom.
			° ′ ″	° ′ ″			°	°	°
May 16	....	1	39 15 00	73 48 00	21	Hard sand.	50	52.5	45.8
16	....	11.15	39 31 30	72 50 00	38	....do........	50	50	41
17	6.15	....	39 27 30	72 50 30	38	....do........	45	48	41
17	....	12.45	39 35 00	72 48 00	36	....do........	49	49.5	44
17	....	11	39 52 00	72 33 00	35	....do........	48	48	40
18	4	....	39 55 00	72 28 00	34	Muddy........	49	48.5	40
18	8.35	....	39 56 00	72 14 00	45	....do........	50	47.5	40.5
18	....	5	40 21 00	72 47 30	27	....do........	50	49	42
19	7	....	40 13 00	72 19 00	35	....do........	50	48	39
19	....	4.30	40 38 00	71 49 00	36	....do........	48	47.5	41
20	8	....	....	....	....	....	50	48.5	....
20	12 m	....	....	....	....	....	55	49.5	....
20	....	4	....	....	....	....	55	51	....
21	8	....	Wood's Holl, Mass		....	....	47	50	....
21	12 m	....	....do........		....	....	55	54	....
21	....	4	....do........		....	....	55	55	....
22	8	....	....do........		....	....	55	51	....
22	12 m	....	....do........		....	....	58	54	....
22	....	4	....do........		....	....	56	55	....
23	8	....	....do........		....	....	55	52	....
23	12 m	....	....do........		....	....	64	53	....
24	8	....	....do........		....	....	60	52.5	....
24	12 m	....	....do........		....	....	60	52.5	....
24	....	4	....do........		....	....	59	52.5	....
25	8	....	....do........		....	....	55	53	....
25	12 m	....	....do........		....	....	60	53	....
25	....	4	....do........		....	....	58	53	....
26	8	....	....do........		....	....	54	53	....
26	12 m	....	....do........		....	....	56	53	....
26	....	4	....do........		....	....	54	53	....
27	8	....	....do........		....	....	56	52.5	....
27	12 m	....	....do........		....	....	63	53	....
27	....	4	....do........		....	....	60	53	....
28	8	....	....do........		....	....	55	52.5	....
28	12 m	....	Off Gay Head........		....	....	50	54	....
28	....	4	Off Brenton's Reef.		....	....	50	50	....
29	8	....	Newport, R. I., Harbor.		....	....	55	51	....
29	12 m	....	....do........		....	....	65	53	....
29	....	4	....		....	....	55	48.5	....
30	....	3.25	40 47 30	70 55 00	31	Hard........	57	49	40
30	....	10	40 50 00	70 46 00	32	....do........	51	48	41
31	6.30	....	40 47 00	70 39 00	32	....do........	51	48	N. S.
31	10	....	40 45 30	70 36 00	32	....do........	53	48	40.5
June 1	10	....	41 09 00	71 03 00	20	....do........	54	49	N. S.
1	10.30	....	41 11 30	71 01 00	19	....do........	54	49	N. S.
2	8	....	Wood's Holl, Mass.		....	....	58	56	....
2	12 m	....	....do........		....	....	68	57	....
2	....	4	....do........		....	....	70	57	....
3	8	....	....do........		....	....	59	56	....
3	12 m	....	....do........		....	....	65	57.5	....
3	....	4	....do........		....	....	64	60.5	....
4	8	....	....do........		....	....	65	59.5	....
4	12 m	....	....do........		....	....	67	61.5	....
4	....	4	Tarpaulin Cove ...		....	....	64	57	....
5	....	7	40 35 15	70 22 00	25	Hard........	59	55	41.7
6	8.15	....	40 28 30	69 49 30	38	Soft........	56	52	41.5
6	10.35	....	40 42 00	69 53 00	29	....do........	57	50	42
6	6.30	....	40 22 00	70 04 00	45	....do........	57	53	44
7	4.40	....	40 13 00	69 58 00	48	Hard........	57	53	45
7	....	1.05	40 37 30	70 53 00	28	Soft........	60	54	....
7	....	3.25	40 57 00	71 03 00	26	....do........	64	53	....
8	8	....	Off Newport Harbor.		....	....	58	58	....
8	12 m	....	....do........		....	....	65	58	....
8	....	4	....do........		....	....	69	57	....
9	8	....	....do........		....	....	63	58	....
9	12 m	....	Off Brenton's Reef.		....	....	68	58	....
9	....	4	Off Block Island...		....	....	58	55.5	....
10	9.40	....	40 45 00	71 32 00	34	....	57	58	40.1
11	8	....	Block Id. Harbor..		....	....	62	55.5	....
11	12 m	....	....do........		....	....	64	56	....
11	....	4	....do........		....	....	66	58	....
13	11	....	40 29 00	72 19 00	31	Hard........	68	58.5	41.5

7.—A REVIEW OF THE LABROID FISHES OF AMERICA AND EUROPE.

By David Starr Jordan.

In this paper, I have tried to give a systematic catalogue of all the species of Labroid fishes (Old-wives, Wrasses, Doncellas, Pudianos, Parrot-fishes, etc.) found in the waters of America and Europe, with the synonymy of each species and analytical keys by which the various genera and species may be distinguished. In the preparation of this work I have been especially indebted for important aid to my wife, Jessie Knight Jordan.

The material examined comprises the collections of the Indiana University, rich in West Indian and Mediterranean fishes; a considerable part of the American *Labridæ* in the U. S. National Museum; the Sandwich Island collections of Dr. Oliver P. Jenkins; all the *Scarinæ* in the Museum of Comparative Zoology, and a large part of the fishes of this family in the Museum at Paris.

Of about one hundred and twenty species of *Labridæ*—American and European, I have examined two-thirds. The following species I have not seen.

Centrolabrus exoletus.	Harpe tredecimspinosus.	Malapterus reticulatus.
Centrolabrus trutta.	Harpe pulchella.	Callyodontichthys bleekeri.
Acantholabrus palloni.	Lepidaplois scrofa.	Sparisoma strigatum.
Labrus berggylta.	Graus nigra.	Sparisoma maschalespilos.
Labrus comber.	Trochocopus maculatus.	Sparisoma aracanga.
Labrus nubilus.	Pimelometopon darwini.	Scarus aracanga.
Symphodus melanocercus.	Pseudolabrus gayi.	Scarus acutus.
Symphodus pirca.	Leptojulis bimaculatus.	Scarus flavomarginatus.
Ctenolabrus iris.	Thalassoma nitidum.	Scarus simplex.
Ctenolabrus suillus.	Thalassoma steindachneri.	Scarus pleianus.
Ctenolabrus brandaonis.	Thalassoma pavo.	
Harpe eclancheri.	Xyrichthys modestus.	

I have preferred to unite the Labroid and Scaroid fishes in a single family, *Labridæ*, as the two groups are very closely similar in all respects excepting in their dentition, both of the mouth and the pharyngeals. In the matter of the dentition of the jaws there is a strong tendency towards transition into the Labroid type seen in some of the genera of Scaroids. We therefore recognize the *Scarinæ* as forming one of the suborders of the *Labrinæ*. The other *Labrinæ* show characters less strongly marked.

The *Labrinæ* are the most generalized forms, well distinguished from the others by their greater number of vertebræ, a character associated

with the greater number of dorsal spines, and with their northern habitat. These are the only Labroids properly belonging to the north temperate zone, and all but two of the species are European.

The *Malapterinæ* seem to be allied to the *Labrinæ*, although they may belong to some other family. The number of vertebræ have not been counted in the single known species. It belongs to the South Temperate Zone, and differ from the *Labrinæ* in having most of its dorsal spines replaced by soft rays.

The *Harpinæ* are allied to the *Labrinæ*, but are chiefly tropical fishes with a reduced number of vertebræ and spines. Close to the *Bodianinæ* is the small subfamily of *Clepticinæ*, distinguished by the little development of the jaws and pharyngeals and by the correspondingly feeble dentition.

The *Julidinæ* are the most abundant of the tropical Labroids, brilliant little fishes, abounding about banks and reefs, and having the vertebræ reduced to the normal number 10+14=24 and the dorsal spines to about nine.

The *Scarinæ* are almost exclusively tropical. They have the normal number of vertebræ and of spines. Their pharyngeal bones and teeth are, however, modified in a very singular way, and they must be regarded as forming the most specialized type of *Pharyngognathi*, the suborder to which the Labroids belong. Professor Cope regards this suborder as the most specialized or "highest" in the group of fishes. The specialization of the Labroids is, however, reducible to two or three characters, the specialization of the pharyngeal bones, the gills, and in general of the pigment cells. In general they are not less generalized than the majority of the *Acanthopteri*, and they do not depart so widely from the usual fish type as do the *Pediculati*, *Plectognathi* or *Heterosomata*.

NUMBERS OF VERTEBRÆ.

The fact that northern forms have an increased number of vertebræ is well shown in this group. The following table shows the numbers of vertebræ as given by Doctor Günther* in the species examined by him.

* "It will be evident that in those genera which are composed entirely or for the most part of tropical species, the vertebral column is composed of twenty-four or nearly twenty-four vertebræ, whilst those which are chiefly confined to the temperate seas of the Northern or Southern hemisphere have that number increased in the abdominal and caudal portions." (Günther, IV, 65.) This increase in the number of vertebræ in northern forms has been used as a basis of the classification of the *Pleuronectidæ*, by Jordan & Goss, of the *Scorpænidæ*, by Jordan & Gilbert, and it will doubtless prove to have a high value in the subdivision of other families which have representatives in different zones. The cause of this peculiarity of fishes of cold waters is still obscure. Probably the reduction in number of segments is a result of the specialization of structure incident to the sharper competition of the tropical waters, where the outside conditions of life are very favorable for fishes, but the struggle of species against species is most severe.

Labrus viridis, 20+21 = 41.
Labrus bimaculatus, 18+21 = 39.
Labrus livens, 18+20 = 38.
Labrus berggylta, 19+19 = 38.
Ctenolabrus adspersus, 17+19 = 36.
Acantholabrus palloni, 18+18 = 36.
Odax balteatus (Antarctic), 19+17 = 36.
Hiatula onitis, 16+18 = 34.
Ctenolabrus suillus, 15+18 = 33.
Symphodus melops, 15+18 = 33.
Symphodus tinca, 15+18 = 33.
Symphodus ocellaris, 14+18 = 32.
Symphodus cinereus, 14+17 = 31.
Symphodus scina, 13+18 = 31.
Symphodus mediterraneus, 13+17 = 30.
Lachnolaimus maximus, 12+17 = 29.
Lepidaplois scrofa, 11+17 = 28.
Lepidaplois hirsutus, 11+17 = 28.
Decodon puellaris, 12+16 = 28.*
Clepticus genizara, 10+17 = 27.*
Anampses cœruleopunctatus, 11+15 = 26.
Duymæria aurigaria, 10+15 = 25.
Halichœres nigrescens, 10+15 = 25.
Hemitautoga hortulanus, 10+15 = 25.
Thalassoma pavo, 11+14 = 25.
Thalassoma lunare, 11+14 = 25.
Thalassoma dorsale, 11+14 = 25.
Julis julis, 11+14 = 25.
Julis atlantica, 11+14 = 25.
Coris aygula, 11+14 = 25.
Güntheria trimaculata, 10+15 = 25.
Pseudolabrus psittaculus, 9+16 = 25.
Pseudolabrus laticlavius, 9+16 = 25.
Gomphosus tricolor, 9+15 = 24.
Pseudolabrus celidotus, 10+13 = 23.
Xyrichthys macrolepidotus, 10+15 = 25.
Xyrichthys novacula, 9+16 = 25.
Cheilinus fasciatus, 10+13 = 23.
Cheilinus trilobatus, 10+13 = 23.
Sparisoma cretense, 11+14 = 25.

As in most other large groups there has been shown considerable difference of opinion as to the characters which should be used in dividing the Labroids into genera. The tendency with all recent writers has been towards a rather minute subdivision. The numbers of vertebræ seem to us to yield characters of the highest importance. Other characters not to be neglected can be drawn from the size of the scales, the numbers of the dorsal spines, and the dentition. The degree of squamation of the head seems to us to have an importance lower than that attributed to it by Bleeker and Günther. The number of genera as given in this paper could bear reduction only in the *Harpinæ* and *Julidinæ*. The genera of the *Labrinæ* seem to us natural enough, and most of those of the *Scarinæ* are most trenchantly separated.

ANALYSIS OF SUBFAMILIES OF LABRIDÆ.

a. Lower pharyngeals T-shaped or Y-shaped, their teeth conical or tubercular; teeth in jaws more or less distinct. Carnivorous species, the sexes usually not colored alike.

b. Dorsal spines 8 or more, usually well separated from the soft rays; anal spines 3 to 6 (rarely 2).

c. Vertebræ about 36 (15 + 18 to 20 + 21); dorsal spines 14 to 21; anal spines 3 to 6; all the spines pungent; anterior canines $\frac{4}{4}$; no posterior canines; lateral line complete; caudal fin never forked. Species of northern waters, none of them tropical. .... LABRINÆ, A.

cc. Vertebræ 22 to 29; dorsal spines 8 to 13; (species of tropical or subtropical seas.)

e. Vertebræ 27 to 29 (so far as known); dorsal spines usually 12 (11 to 14); sides of head more or less scaly; preopercle serrulate or entire.

f. Anterior canines strong; lower pharyngeals large, with large, tubercular teeth; spinous dorsal not enveloped in scales; lower jaws naked. HARPINÆ, B.

* In specimens examined by us.

ff. Anterior teeth very small, not canine-like; lower pharyngeals very small, with small, coalescent teeth; spinous dorsal enveloped by scales; lower jaw scaly .... CLEPTICINÆ, C.

ee. Vertebræ 23 to 25 (rarely 26); dorsal spines 8 or 9 (rarely more); anterior canines strong $\frac{2\text{ to }4}{2\text{ to }4}$; head usually naked, the cheeks sometimes scaly; preopercle entire .... JULIDINÆ, D.

bb. Dorsal spines 3; anal spines 2; the spines all very slender and flexible, essentially similar to the soft rays; body elongate; preopercle entire; sides of head scaly; lateral line complete; anterior canines about $\frac{4}{2}$; vertebræ probably numerous. Species of the South Temperate Zone .... MALAPTERINÆ, E.

aa. Teeth in jaws more or less perfectly confluent; lower pharyngeals more or less spoon-shaped or basin-shaped, their teeth broadest transversely and truncate, arranged in a sort of mosaic; anal spines 2; dorsal spines 9; scales very large, 23 to 25 in the lateral line; vertebræ about $11+14=25$. Herbivorous species, the sexes similarly colored. SCARINÆ, F.

Subfamily A.—LABRINÆ.

(Labroid fishes with the vertebræ and dorsal spines in increased number. Species of moderate or small size, nearly all European and all confined to the North Temperate Zone.)

a. Anal spines 4 to 6; dorsal spines 16 to 21; cheeks and opercles scaly; scales rather large; preopercle serrate.

b. Teeth small in single series; mouth small; dorsal fin nearly scaleless. CENTROLABRUS, 1.

bb. Teeth larger, in about two series; mouth large; dorsal fin scaly. ACANTHOLABRUS, 2.

aa. Anal spines, 3.

c. Teeth in one series; cheeks and opercles scaly.

d. Scales small, 43 to 55 in the lateral line; preopercle entire (in the adult); lips very thick; teeth strong; dorsal spines 17 to 21; vertebræ 38 to 41 .... LABRUS, 3.

dd. Scales large, 30 to 35 in the lateral line; preopercle serrulate; dorsal spines 14 to 16; vertebræ 30 to 32 .... SYMPHODUS, 4.

cc. Teeth in more than one series.

e. Preopercle serrate; opercles scaly; scales moderate or large . CTENOLABRUS, 5.

ee. Preopercle entire; opercles naked; scales small .... HIATULA, 6.

Subfamily B.—HARPINÆ.

(Labroids with the vertebræ 28 to 29; the dorsal spines 11 to 14, and the jaws with strong canines. Species mostly of large size and bright coloration, inhabiting warm seas.)

a. Dorsal spines about 14, the 3 or 4 anterior falcate produced in long streamers; body deep and compressed, the anterior profile steep; teeth uniserial; no posterior canine; cheeks and opercles scaly; bases of soft dorsal and anal scaly; soft parts of vertical fins produced; scales moderate (40) .... LACHNOLAIMUS, 7.

aa. Dorsal spines 11 or 12 (rarely 13), none of them produced in filaments; cheeks and opercles scaly; body oblong; the back not greatly elevated.

b. Soft dorsal and anal fins each with a scaly sheath at base; scales large (about 32); posterior canine present.

c. Soft dorsal and anal elevated, produced behind .... HARPE, 8.
cc. Soft dorsal and anal low, their outline rounded .... LEPIDAPLOIS, 9.
bb. Soft dorsal and anal without sheath of scales; preopercle serrulate (at least in young); soft dorsal and anal more or less falcate.
d. Scales large, about 30; lower limb of preopercle scaly; posterior canine present; anterior canines $\frac{4}{4}$ .... DECODON, 10.
dd. Scales moderate or small, 45 to 60; both limbs of preopercle naked; adult male with a fleshy hump on the forehead; caudal subtruncate, with the angles more or less produced.
e. Posterior canine present; anterior canines $\frac{4}{4}$; dorsal spines 12.
TROCHOCOPUS, 11.
ee. Posterior canine obsolete; anterior canines $\frac{8}{10}$; dorsal spines 13.
GRAUS, 12.

Subfamily C.—CLEPTICINÆ.

(Labroids with the vertebræ about 27, the dorsal spines 12, and the jaws and lower pharyngeals very small, with small teeth, which are not canine-like. A single species in tropical America.)

a. Anterior teeth small, bluntish, not canine-like; no posterior canine; mouth very small, terminal; snout short and blunt; dorsal and anal enveloped in scales, except produced tips of both fins; caudal deeply forked; dorsal spines almost hidden by series of scales; head everywhere closely scaled, except on lips and snout; scales of body large; preopercle serrulate; gill-rakers slender, short; pectoral falcate; lower pharyngeals very small, Y-shaped; their teeth small, very blunt and coalescent; vertebræ 10+17 .... CLEPTICUS, 13.

Subfamily D.—JULIDINÆ.

(Labroid fishes with the vertebræ and dorsal spines in moderate number. Species of the tropics, mostly of small size and bright coloration.)

I. Lateral line complete and continuous.
a. Snout not tubiform; preopercle entire; teeth uniserial; none of the teeth chisel-shaped.
b. Cheeks and opercles scaly; posterior canine present; scales large; snout pointed; base of dorsal without scaly sheath.
PSEUDOLABRUS, 14.
bb. Cheeks and opercles naked.
c. Scales small, 70 to 80 in the course of the lateral line; dorsal spines 9, all, except sometimes the two anterior, pungent; posterior canines present; anterior canines mostly $\frac{4}{4}$; the outer pair sometimes small; lips very fleshy; lower pharyngeals T-shaped, the posterior border not concave, the median tooth of the posterior row blunt, enlarged; anal spines 3........JULIS, 15.
cc. Scales large, 25 to 30 in the lateral line; anal spines, 2 or 3.
d. Dorsal spines 9; dorsal enlarged, without scaly sheath; scales of breast not enlarged.
e. Anterior canines $\frac{4}{4}$, the outer enlarged, bent outwards and backwards; lower pharyngeals Y-shaped, the posterior border concave.
LEPTOJULIS, 6.
ee. Anterior canines all normal in position; lower pharyngeals T-shaped, with numerous teeth.
f. Posterior canine well developed on both sides; dorsal spines pungent.. HALICHŒRES, 17.

ff. Posterior canines wanting or reduced to a slight rudiment. PSEUDOJULIS, 18.

dd. Dorsal spines 8; no posterior canines; anterior canines $\frac{2}{2}$, normal in position; low sheath of scales at base of dorsal; dorsal spines pungent .... THALASSOMA, 19.

II. Lateral line interrupted posteriorly, beginning again on the level of the axis of the body, on the caudal peduncle.

g. Scales large, 20 to 30 in the lateral line; dorsal spines 9.

h. Posterior canine present; snout slender, the anterior profile not convex; cheeks and opercles scaly; dorsal spines pungent, the three anterior longer and with filamentous appendages; dorsal and anal with a scaly sheath; scales very large. DORATONOTUS, 20.

hh. Posterior canine none; anterior profile more or less convex; head naked except usually a few scales below the eye; canines usually $\frac{2}{2}$; body more or less strongly compressed.

i. Scales very large, about 20 in the lateral line, which is placed on the first row of large scales below the dorsal sheath; anterior dorsal spines not detached .... XYRULA, 21.

ii. Scales large, about 26 in the lateral line, which is placed on the second row of large scales below the dorsal sheath.

j. First two dorsal spines joined by membrane to the others and inserted nearly above base of pectorals ... XYRICHTHYS, 22.

jj. First two dorsal spines detached from the others and inserted on or close behind the occiput .... INIISTIUS, 23.

Subfamily E.—MALAPTERINÆ.

(Labroid fishes with the dorsal spines scarcely developed, similar to the soft rays, and in very small number. Species of the South Temperate Zone.)

a. Body rather elongate; cheeks scaly; opercles with small scales above and with a row of large scales along posterior border; preopercle entire; teeth in one series; no posterior canine; lateral line continuous; dorsal and anal spines scarcely different from the soft rays. D. III, 29; A. II, 19 .... MALAPTERUS, 24.

Subfamily F.—SCARINÆ.

Labroid fishes with the lower pharyngeals concave, covered with flattish or tesselated teeth, which are transversely oblong and compressed, not conical; teeth in jaws more or less coalescent. Scales large; vertebræ about 25. Fishes of moderate or large size, all tropical, mostly of brilliant coloration, the sexes similar. (Parrot fishes.)

a. Lower pharyngeals broader than long, flattish or basin-shaped; gill membranes broadly joined to the isthmus, not forming a fold across it; lateral line subcontinuous; scales about head few and large, those on the cheeks in one row; lower jaw projecting.

b. Dorsal spines flexible; teeth more or less distinct, at least anteriorly.

c. Teeth in both jaws in few series, not imbricated in quincunx; lateral teeth of both jaws coalescent in a more or less continuous cutting edge; the teeth more free anteriorly and not adnate to the dental plate.. CRYPTOTOMUS, 25.

cc. Teeth in both jaws in three or four series, all imbricated in quincunx order on the dental plate, to which they are adnate by the posterior face; cutting edge of both jaws formed by the teeth .... CALOTOMUS, 26.
bb. Dorsal spines stiff, pungent; teeth of upper jaw at least more or less coalescent.
d. Teeth of lower jaw distinct, disposed in oblique series. . CALLYODONTICHTHYS.
dd. Teeth of both jaws chiefly coalescent, the jaws divided by a rather indistinct median suture .... SPARISOMA, 27.
aa. Lower pharyngeal spoon-shaped, much longer than broad; teeth of jaws fully coalesced; each jaw divided by a distinct median suture; gill-membranes forming a fold across the isthmus; dorsal spines flexible; lateral line interrupted behind, beginning again lower down on the peduncle of the tail; scales about head rather numerous, those on cheeks in two or more series; lower jaw included .... SCARUS, 28.

Genus I.—CENTROLABRUS.

Centrolabrus Günther, Cat. Fish. Brit. Mus., iv, 92, 1862 (*exoletus*).

TYPE: *Labrus exoletus* L.

Etymology: *Κέντρον* spine; *Labrus*, an allied genus.

This genus contains two or three species, found on the coasts of Europe, one of them ranging farther to the north than any other Labroid fish.

ANALYSIS OF SPECIES OF CENTROLABRUS.

a. [Dorsal rays XVIII to XX, 6. Anal rays V, 7 or 8; body rather robust; the snout of moderate length, about $3\frac{1}{3}$ in head; mouth very small, its cleft reaching barely half way to front of eye; eye rather large; dorsal spines low, the soft rays somewhat higher, but lower than the anal; caudal rounded. Head $3\frac{1}{2}$ in length; depth $3\frac{1}{2}$; scales = 3–33–10, three rows on cheeks; color rich brown, the sides shaded with yellow; narrow yellow lines along the rows of scales; a dark spot on eye, above; two blue bands from eye to angle of mouth, and two more across preopercle; no black spot behind eye; a dull bluish mark on opercle; fins yellowish-silvery; a line of dark marks along spinous dorsal; caudal with a black base and a white outer margin.] (*Day*)..... EXOLETUS, 1.
aa. [Dorsal rays XVI or XVII, 8 or 9; Anal rays IV, 9, or V, 8; teeth equal, close-set; a dull spot behind the orbit; sometimes a spot at the root of the caudal fin; coloration dark green, back with interrupted cross-bars, sides sometimes with indistinct darker longitudinal streaks; depth $3\frac{1}{2}$ in length. D. XVII, 8. A. IV, 9, or V, 8. Scales 3–34–11.] (*Günther*)...................... TRUTTA, 2.

1. CENTROLABRUS EXOLETUS.

(ROCK COOK.)

Labrus exoletus Linnæus, Syst. Nat. Ed. x, 1758, 274. (Atlantic Ocean.) Ed. xii, 479. Fabricius, Fauna Grönlandica, 1780, 166. (Greenland) (and of the early writers).
Acantholabrus exoletus Cuv. & Val., xiii, 247 (copied); Collett, Norges Fiske, 94 (and of several authors).
Centrolabrus exoletus Günther, iv, 92; Day, Fish. Gt. Britain, 267.
Labrus pentacanthus Lacépède, Hist. Nat. Poiss., iii, 503, 1803 (after Linnæus).
Crenilabrus microstoma (Couch) Thompson, "Proc. Zool. Soc. London, 1837, 55."

Habitat.—Coasts of northern Europe, south to Cornwall; said to range westward to Norway.

Etymology: *Exoletus*, antiquated; said to be in allusion to the anomalous number of five spines in the anal.

We have not studied this species, and have taken our description of it chiefly from the account given by Dr. Day. It is the most northern in its range of all the Labroid fishes.

2. CENTROLABRUS TRUTTA.

(VERDE.)

Crenilabrus trutta Lowe. "Proc. Zool. Soc. London, i, 1833, 143." (Madeira).
Centrolabrus trutta Günther, i, 93 (Madeira.)
Acantholabrus viridis Cuv. & Val., xiii, 252, 1839 (Canaries).
? *Acantholabrus romerus* Valenciennes, Webb & Berthelot, Ichth. Îles Canaries, 64 (Canaries).
? *Acantholabrus romeritus* Valenciennes, l. c. (Canaries).

Habitat.—Madeira and Canary Islands.

Etymology; *trutta*, low Latin word for trout.

We know this species only from descriptions. We follow Dr. Günther in regarding *romerus* and *romeritus* as probably indentical with *trutta*. Possibly two species exist, *trutta* with five anal spines and *viridis* (= *romeritus*) with but four.

Genus II.—ACANTHOLABRUS.

Acantholabrus Cuv. & Val. xiii, 242, 1839 (*palloni*).

TYPE: *Lutjanus palloni* Risso.

Etymology: *Ἀκανθα*, a spine; *Labrus*, an allied genus.

This genus contains but one (possibly two) species, found in the waters of Europe.

ANALYSIS OF SPECIES OF ACANTHOLABRUS.

a. [Body rather elongate; head long, with pointed snout, which is nearly one-third the length of the head; mouth large, the maxillary reaching the front of the large eye; spines rather long, the posterior longest; soft dorsal and anal somewhat elevated; both spinous and soft dorsal scaly; caudal rounded; pectorals and ventrals short; head, $3\frac{3}{4}$; depth, 4. D. XX or XXI, 10. A. V, 9. Scales 4–42–16. Color, olive, varying to orange or bluish above; sides yellowish; usually a dark blotch at base of caudal, above lateral line; a large, black blotch on last dorsal spines and the first soft rays; blue spots sometimes present on the scales of lower parts, especially anteriorly.] (*Day*, etc.) ....PALLONI, 3.

3. ACANTHOLABRUS PALLONI.

(TENCO.)

Lutjanus palloni Risso, Ichth. Nice, 1810, 263 (Eza).
Acantholabrus palloni Cuv. & Val., xiii, 243, 1839 (and of Günther, Steindachner, and recent writers generally).
Acantholabrus imbricatus Lowe, "Proc. Zool. Soc., London, 1839, 86" (Madeira).
Acantholabrus couchi Cuv. & Val., xiii, 248 (Cornwall, after Couch); Günther, iv, 92; Collett, Norges Fiske, 1875, 93 (Flekkefjord).

Habitat.—Deep waters in the Mediterranean, north to southern England and south to Madeira.

Etymology: *Palloni;* a personal name unexplained by the author.

This rather rare species is known to us only from descriptions. Judging from published accounts there is not much doubt that *A. couchi*, with 6 anal spines, is an individual variation of *A. palloni.*

Genus III.—LABRUS.

Labrus Artedi, Genera, etc., 1734. (Includes all known *Labridæ*, and other fishes supposed to be related to them.)

Labrus Linnæus, Syst. Nat., Ed. x, 1758, 282 (*viridis, bimaculatus, turdus, mixtus*, and many other species, many of them non-labroid).

Scarus Gronow, Museum Ichthyol., 1764, ii, 8 (non binominal) (*viridis* = *livens.*)

Labrus Rafinesque, Caratteri, etc., 1810, 36 (restricted to Labroid fishes).

Labrus Cuvier, Règne Animal, Ed. i, 1817, 261 (*Labrus vetula* Bloch, and relatives).

TYPE.—*Labrus bimaculatus* Linnæus.

Etymology: *Labrus*, a name taken by Artedi from Pliny and Ovid, thought by Artedi to be from *labrum*, lip, on account of the thick lips. The original word is apparently from λάβρος, meaning voracious. Rondelet uses the name for the thick-lipped mullet, *Mugil chelo* Cuvier.

This genus, as now restricted, contains about six species, all of them belonging to the seas of Europe. Most of them are gaily colored, and some of them show great variations in color in accordance with sex and age.

ANALYSIS OF SPECIES OF LABRUS.

a. Scales comparatively large, 39 to 45 in the lateral line; lateral canines large, not much smaller than anterior.

b. Dorsal spines 20 to 21, the soft rays 10 or 11; body rather robust, the depth about equal to length of head, 3⅗ in length; snout short, not acute, about 3 in head; eye small, 5½ in head; width of scaly part of cheek about equal to eye. Color, green or brown, usually much spotted or reticulated with orange red; vertical fins mostly green, variously spotted; paired fins orange red.

c. [Sides without distinct silvery lateral band; head with curved streaks and other markings, but without blue longitudinal stripes; spinous dorsal notably lower than soft dorsal.] (*Day.*)................BERGGYLTA, 4.

cc. [Sides with a distinct silvery lateral band; head with longitudinal blue stripes; spinous dorsal comparatively higher.] (*Day.*) Otherwise as in the preceding, of which it is probably a color variety ....COMBER, 5.

bb. Dorsal spines, 17 to 19; soft rays, 11 to 13.

c. Body robust, the depth about equal to length of head, 3⅓ in body; snout short, bluntish, barely one-third head; lips thick; sides of body usually without silvery band.

d. Coloration nearly plain brown; the young with a dark blotch on the opercle and with dark cross-blotches or dark streaks along the rows of scales; eye small, 6 in head, much narrower than scaly part of cheek; interorbital area two-thirds length of snout; dorsal spines low, much lower than the rather high soft rays ....LIVENS, 6.

dd. [Coloration brown, reticulated with chestnut, each scale with a pale center; dark spots before and behind eye; fins spotted or plain; a silvery lateral band sometimes present.] (*Günther.*) Otherwise as in preceding, of which it is probably a variety, though its coloration is more like that of *L. viridis* .... NUBILUS, 7.

cc. Body rather elongate, the depth less than the length of the head; depth $3\frac{3}{5}$ in length; head about $3\frac{1}{4}$, snout rather long, about $2\frac{3}{5}$ in head; eye small, 6 in head, not so broad as scaly part of cheek; interorbital width about half snout; dorsal spines not much lower than the soft rays; ground color chiefly green, of varying shade; a silvery or paler longitudinal band always present, but sometimes interrupted or obscured; sides usually spotted with blue; blue or pearl colored ocelli sometimes present on the vertical fins (var. *festivus*), or on body and fins (*prasostictus*), or reduced to blue spots (*viridis*) .... VIRIDIS, 8.

aa. Scales comparatively small, 50 to 55 in the lateral line; dorsal rays XVII to XVIII, 11 to 13; anterior canines $\frac{4}{4}$, the lateral canines somewhat smaller; body elongate, the depth considerably less than length of head; depth 4; head 3; snout very long and sharp, $2\frac{3}{4}$ in head, about twice the interorbital space; eye large, $4\frac{2}{3}$ in head, considerably wider than scaly part of cheek; maxillary long, $2\frac{4}{5}$ in head, the mouth longer than in the other species; dorsal spines slender, little lower than the soft rays. Coloration extremely various, the sexes unlike; a large dark blue blotch on front of spinous dorsal in both sexes, this largest in the males; caudal and anal with blue margins; males usually with a broad dusky lateral band or else with blue longitudinal streaks; females nearly plain, reddish, with three or four large blackish blotches along base of soft dorsal and back of caudal peduncle, these very obscure in the male; sometimes a dark shade at base of caudal .... BIMACULATUS, 9.

4. LABRUS BERGGYLTA.

(BERGLE; BALLAN-WRASSE; OLD-WIFE.)

Labrus berggylta Ascanius, "Icones, t. 1, 1772;" Collett, Norges Fiske, 1775, 91, and of numerous writers.

Labrus berg-galt Müller, "Zool. Danica Prodromus, 46, 1776."

Labrus maculatus Bloch, Ichthyol., vi, 17, t. 294, 1792; Günther, iv, 70; Steindachner, Ichth. Berichte, 1868, 27; Day, British Fishes, 252, and of numerous authors.

Labrus ballan Walbaum, Artedi Pisc., 259, 1792 (after the Ballan-wrasse of Pennant).

Labrus tinca Lacépède, Hist. Nat. Poiss, iii, 439, 1802 (not of Linnæus).

Labrus neustriæ Lacépède, l. c., 501 (Rouen).

Labrus lineatus Turton, "British Fauna, 99, 1807."

Labrus cornubiensis Couch, "Trans. Linn. Soc., xiv, 80," 1832.

Labrus pusillus Jenyns, "Man. Brit. Vert., 1835, 392" (Young).

Crenilabrus multidentatus Thompson, "Proc. Zool. Soc. London, 1837, 56" (Young).

Labrus variabilis Thompson, "Proc. Zool. Soc. London, 1837, 58."

Habitat.—Coasts of Europe, from Norway to the Mediterranean, most abundant northward.

Etymology: The Norwegian name of the fish, from *berg*, cliff.

This species is abundant on the rocky coasts of northern Europe. It is excessively variable in color, like most of the members of the family. We have examined specimens in the fish market of Bergen. The synonymy above given is chiefly on the authority of Günther and Day.

The Norwegian name *berggylta* seems to have clear priority over the name *maculatus* for the species, although the latter name has been more generally used.

5. LABRUS COMBER.

(COMBER.)

Comber Pennant, "British Zoology, iii, 252, pl. 47, f. 123, 1776" (Cornwall).
Labrus comber Gmelin, Syst. Nat., 1788, 1297 (after Pennant).
Labrus donovani Cuv. & Val., xiii, 39, 1839 (Brittany); Steindachner, Ichth. Berichte, 1868, 25, t. iv, f. 2; Day, British Fishes, 253; and of most authors.

Habitat.—Coasts of Europe, north to England.

Etymology: *Comber*, the Cornish name of the species.

We have not seen this species. Dr. Day regards it as a variety of *Labrus berggylta*, from which it seems to differ chiefly in the coloration.

6. LABRUS LIVENS.

Turdus niger, Merula Salviani Willughby, 320.
Labrus cæruleo-nigricans Artedi, Synonymia, 55 (after Willughby).
Labrus livens Linnæus, Syst. Nat., x, 287, 1758 (description incomplete).
Labrus merula Linnæus, Syst. Nat., Ed. x, 288, 1758 (after Artedi); Cuv. & Val. iii, 80; Günther, iv, 72; and of Steindachner and nearly all recent writers.
Labrus crassus Agassiz, Spix, Pisc. Brazil, 1829, 95, tab. 52 (coast of Brazil)?
Labrus psittacus Risso, "Eur. Mérid., 1826."
Labrus lividus Cuv. & Val., Hist. Nat. Poiss, xiii, 87, 1839.
Labrus limbatus Cuv. & Val., l. c., 89.
Labrus lineolatus Cuv. & Val., l. c., 90.
Labrus saxorum Cuv. & Val., l. c., 91.
Scarus viridis Gronow, Systema, Ed. Gray, 1854, 63.

Habitat.—Coast of southern Europe. (Brazil?).

Etymology: *Livens*, "black and blue," growing livid.

Our specimens of this species are from Venice. The species is distinguished from all the others in the group by its plain coloration, compared by Willughby and other early writers to that of the English Blackbird, *Turdus* or *Merula*.

We follow Dr. Steindachner in regarding *L. lineolatus* and *L. saxorum* as the young of *Labrus livens*.

Prof. Agassiz has described from Brazil a *Labrus* allied to *L. merula* under the name of *Labrus crassus*. As no species of this genus is known to occur in American waters, it is perhaps possible that this *Labrus crassus* really came from Europe. In this case, we do not know how to distinguish it from *Labrus livens*.

We have substituted the name *livens* for *merula* as having the priority of a page over the latter name. The description of Linnæus is very short, but the number of dorsal rays (XVIII, 13) shows it to be a *Labrus*, and no other species has "corpore fusco-livido."

7. LABRUS NUBILUS.

Labrus reticulatus Lowe, "Trans. Zool. Soc., 1837, iii, 11" (Madeira); Günther, iv, 73 (not *Labrus reticulatus* Walbaum).
Labrus nubilus Valenciennes, "Webb and Berthelot, Exp. Îles Canaries, 62."

Habitat.—Mediterranean Sea and adjacent islands.

Etymology: *Nubilus*, cloudy.

We know this species from Dr. Günther's description only. It must be very closely allied to *Labrus livens*, but Dr. Günther gives it as distinct.

The name *reticulatus* being pre-occupied in the genus *Labrus*, this species, if valid, will stand as *Labrus nubilus*.

8. LABRUS VIRIDIS.

Turdus viridis minor Willughby, p. 320.
Turdus viridis major Willughby, p. 322.
Turdus oblongus fuscus maculosus Willughby, p. 323.
Labrus viridis linea utrinque cœrulea Artedi, Genera, 34 (after Willughby, 320).
? *Labrus oblongus viridis iride aurea* Artedi, Genera, 34; Synonymia, 57 (after Willughby, 322).
Labrus viridis Linnæus, Syst. Nat., Ed. x, 1758, 286 (after Artedi); Cuv. & Val., xiii, 75, pl. 370.
Labrus luscus Linnæus, Syst. Nat., Ed. x, 287 (habitat unknown).
? *Labrus turdus* Linnæus, l. c. 287 (after Artedi).
Labrus turdus Cuv. & Val., xiii, 62; Günther, iv, 72; and of Steindachner, Day, Canestrini, and most recent writers.
Labrus saphyrinus Walbaum, Artedi, Piscium, 1792, 236 (after Brünnich).
Labrus luteus Walbaum, l. c. (after Brünnich).
Labrus psittacus Lacépède, iii, 501, 1802 (after *L. viridis* Linnæus).
Labrus nereus Risso, Ichth. Nice, 1810, 231.
Labrus zittoides Rafinesque, Caratteri, 38, 1810.
Labrus zittus Rafinesque, l. c.
? *Labrus porcus* Rafinesque, l. c., 39.
Labrus prasostictus Pallas, Zoogr. Rosso.-Asiat., iii, 272, 1811.
Labrus pincus Nardo, "Prodromus, Adriat. Ichthyol., 21, 96, 1827."
Labrus rufus Rathke, "Fauna der Krym., 1839, 337."
Labrus festivus Risso, Europe Mérid., 1826, 304; Canestrini, Labroïdes, 1868, 6.
Labrus nardii Perugia, "Cat. Pesc. Adriat., 1866" (*fide* Canestrini).

Habitat.—Coasts of southern Europe.

Etymology: *Viridis*, green.

Dr. Steindachner remarks:

Es unterliegt keinem zweifel, dass auch *Labr. festivus, nereus, luscus, viridis* und *prasostictus*, welche zum grössten Theile noch in den neuesten Werken als besondere Arten angeführt sind, mit *Labrus turdus* zusammenfallen, da Sie nur auf Farben-varietäten letztgenannter Art basirt sind, deren jede im Wiener Museum durch 3-4 Exemplare vertreten ist.

We have accordingly placed these nominal species in the synonymy as above given. The one of the Linnæan names of this species which has the earliest place on the page is *Labrus viridis*, which is also the

one concerning the application of which there is least doubt. We have, therefore, substituted *viridis* for *turdus* as the specific name of the species.

The specimens of *Labrus viridis* in our collection were taken at Palermo by Professor Doderlein, and in the markets of Paris by Dr. Jordan.

9. LABRUS BIMACULATUS.

(COOK-WRASSE; COOK-CUNNER; RED WRASSE.)

Turdus major varius Willughby, 322 (male).
Labrus ex flavo et cœruleo varius Artedi, Syn., 57 (after Willughby).
Labrus bimaculatus Linnæus, Syst. Nat., Ed. x, 285, 1758. (Mediterranean Sea); and of a few copyists. (Based on females.)
? *Labrus ossifagus* Linnæus, l. c., 286 ("Europa").
Labrus mixtus Linnæus, l. c., 287 (after Artedi); Cuv. & Val., xiii, 43; Günther, iv, 74; Steindachner, Ichth. Ber., ii. 1868, 23; Day, Fish. Great Britain, 256; Collett, Norges Fiske, 91; and of authors generally.
Labrus cœruleus Ascanius, "Icones, t. xii. 1772 (male)."
Labrus carneus Ascanius, l. c., t. xiii (female) and of various authors.
Labrus variegatus Gmelin, Syst. Nat., 1788, 1294 (on the Striped Wrasse of Pennant); and of numerous early authors.
Labrus trimaculatus Gmelin, l. c., 1294 (female), and of various authors.
Labrus coquus Gmelin, l. c., 1297 (male) (on the "Cook" of Pennant) and of various authors.
Labrus vittatus Walbaum, Artedi, Piscium, 1792, 256 (on the "Striped Wrasse" of Pennant).
Labrus herbeus Walbaum, Artedi, Piscium, 1792, 258 (on the "Grönne Berggyltte" of Ström).
Labrus badius Walbaum, l. c., 258 (on the "Brune og morkplettede Berggylte" of Ström).
? *Labrus microlepidotus* Bloch, Ichth., 1792, taf. 292 (scales much too small for the species of *Labrus*).
Labrus vetula Bloch, Ichth., 1792, taf. 293 (North Sea) and of authors.
Sparus formosus Shaw, "Nat. Misc., i, pl. 31," about 1800.
Labrus cook Bloch & Schneider, Syst. Ichth., 1801, 268 (after Pennant).
Labrus luvarus Rafinesque, Caratteri, 1810, 38.
Labrus quadrimaculatus Risso, Europe Mérid., iii, 302, 1826.
Acantholabrus yarrelli Cuv. & Val., xiii, 1839, 250 (on a specimen said to have 6 anal spines).

Habitat.—Coasts of Europe, north to Norway and Scotland.

Etymology: *Bimaculatus*, two-spotted, in allusion to the color of the dorsal fin in the female.

This handsome and excessively variable species is generally common in the waters of southern Europe. Our specimens, male and female, are from Palermo. We follow Günther, Day, and Steindachner in regarding the species called *carneus* and *bimaculatus* as the female of *Labrus mixtus*. The name *bimaculatus* stands first in the Systema Naturæ, for which reason we have adopted it, though it is by no means an appropriate one.

Genus IV.—SYMPHODUS.

Symphodus Rafinesque, Caratteri di Alcuni Nuovi Generi, 1810, 41 (*fulvescens*).
Crenilabrus Cuvier, Règne Animal, Ed. i, 1817, 263 (*rupestris, bidens, norvegicus*).
Coricus Cuvier, Règne Animal, 1817, 263 (*virescens* Risso = *scina*).
Cynædus Swainson, Nat. Hist. Class'n. Anim., ii, 229, 1839 (*tinca*, etc.).

TYPE: *Symphodus fulvescens* Rafinesque—*Labrus scina* Forskål.

Etymology: Συμφυής grown together, ὀδούς tooth.

This genus is composed of small fishes strongly resembling the young of the genus *Labrus*, but distinguished from the species of the latter genus by the large size of the scales. The species which reach the largest size most resemble the species of *Labrus*, in the large lips, smaller scales, stronger teeth, and weaker serrature of the preopercle. As, however, no really intermediate forms exist, the genus seems to us well established.

We agree with Dr. Günther, that the production of the snout in *S. rostratus* is not a character of such importance as to justify placing that species in a separate genus (*Coricus*). The name *Symphodus* has priority over *Coricus* and *Crenilabrus*,* and must supersede both names if the groups are united.

The species of *Symphodus* are quite variable both in form and coloration. All of them are readily recognized, however, although there are some individuals of almost every species which will not quite answer to the characters given in the following analysis.

ANALYSIS OF SPECIES OF SYMPHODUS.

a. Head not notably long and low, its depth at centre of eye more than half its length and considerably more than length of snout; premaxillaries moderately protractile, the length of their posterier processes from tip of upper jaw backward about one-third head (*Crenilabrus* Cuvier.)

b. Scaly part of cheek comparatively broad, usually broader than eye, and provided with 4 to 6 (rarely 3) rows of scales; dorsal spines 15 to 17; scales 33 to 35; (snout shorter, lips thicker, and preopercle less serrate than in the next group).

c. Base of pectoral with a very conspicuous jet-black spot, which extends on the fin; color usually greenish, the back with very faint dark cross-shades; a large, more or less distinct dusky blotch at base of caudal above; dorsal and anal with a longitudinal dusky shade; all the vertical fins with small blue dots; snout dusky; soft dorsal and anal high, considerably higher than the spines; anterior profile nearly straight; snout $2\frac{3}{5}$ in head; head $3\frac{1}{5}$ in length; depth $3\frac{1}{3}$. D. XVII, 9; A. III, 10; scales on cheek in three or four rows .... MEDITERRANEUS, 10.

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*Swainson remarks: "Mr. Cuvier having expressly stated that the type of his genus *Crenilabrus* is *Lutjanus verres* of Bloch, I have so retained it, placing all the others which seem peculiar to the Mediterranean Seas under the subgenus *Cynædus*." I find no such statement made anywhere by Cuvier.

cc. Base of pectoral without jet-black spot; scales on cheek in 5 or 6 rows; dorsal spines not much lower than the soft rays.

d. Snout of moderate length, $2\frac{1}{5}$ to $2\frac{2}{3}$ in length of head; serrature on preopercle lost with age; eye small, 5 in head; usually an obscure dusky blotch above the base of pectoral and another just below middle of base of caudal; coloration quite variable, usually greenish, with longitudinal series of blue or red spots, or both; sometimes a pale band from head to caudal fin; vertical fins with blue dots; pectoral translucent; three red longitudinal bands sometimes present on sides; sides of head sometimes with blue dots; head $3\frac{2}{5}$; depth $3\frac{3}{5}$; D. XV, 10; A. III, 10; scales 4–35–10 .... TINCA, 11.

dd. [Snout short, about one-third length of head; eye small, 5 in head; usually a curved black blotch close behind eye, often extending forward around lower jaw; a small dark spot at base of caudal just below lateral line; color purplish green; sides of head red, with green bands, edged with darker; sides of body with violet stripes, composed of violet and red spots on the scales; vertical fins green, often with darker spots or ocelli; back and sides sometimes with dusky cross-bands; body short and deep; head $3\frac{1}{2}$; depth $3\frac{2}{5}$; D. XVI, 9; A. III, 10; scales 4–35–12.] (*Day*) .... MELOPS, 12.

bb. Scaly part of cheeks comparatively narrow, usually not so broad as eye, and provided with two or three (rarely four) rows of scales.

x. Opercle without jet-black blotch.

e. Form of body oblong, not elliptical; the depth usually not greater than the length of head, and little if any more than one-third the length of the body.

f. Spinous dorsal with a black blotch on the anterior spines; a large inky black blotch (rarely absent) on lower side of base of caudal fin; a faint brown band along sides from above eye to base of caudal fin; another from below eye to caudal spot; usually a narrow brown streak from eye to chin; body and vertical fins with dark points; snout $2\frac{2}{5}$ in head; eye $4\frac{1}{2}$; head $3\frac{1}{4}$; depth 3; D. XIV, 9; A. III, 9; scales 3–32–9 .... CINEREUS, 13.

ff. Spinous dorsal without distinct black blotch; no black spot on lower edge of caudal.

g. [Sides without dark lateral band; caudal fin yellow, its tip black or with blackish blotches; pectoral fin pale, usually with a black spot towards its tip; color brownish, a curved bluish streak from eye to below lower jaw; eye $3\frac{3}{5}$ in head; snout short, $3\frac{1}{3}$ to 4; depth about $3\frac{1}{3}$ in length; D. XVI, 10; A. III, 9; scales 3–34–8.] (*Günther; Steindachner*) .... MELANOCERCUS, 14.

gg. Sides with a dark lateral band; caudal fin plain, its tip without black blotch; pectoral fin without black spot near its tip; scales 3–35–11; scaly part of cheek as broad as eye; snout short, about 3 in head; anterior profile a little concave, especially in adult; cheeks with three (rarely four) series of small scales; color rose-red; sides with a very distinct broad brown lateral band from snout through eye to upper part of base of caudal, bordered by silvery above and below, the lower of the silvery stripes from angle of mouth to lower half of base of caudal; some small black streaks or spots below lateral band, a small black spot usually present on upper base of caudal; vent black; a dusky lengthwise stripe along dorsal fin; body rather elongate; depth nearly equal to length of head, about 3 in body. D. XV, 10; A. III, 9; scales, 3–35–11 DODERLEINI, 15.

ee. Form of body regularly elliptical, the back and belly somewhat evenly curved, the depth greater than the length of the head and more than one-third the length to base of caudal; no black spot on pectoral or front of spinous dorsal; the caudal spot small and on the median line.

h. [Scales comparatively small, 4½–35 to 38–11; scales on check large, in two series; snout 3 in head; eye about 5; a large, blue-black spot on last spines and first soft rays of dorsal, a smaller one on base of last soft ray, another on middle of caudal; a dark streak across base of pectoral; sides of body with dark cross shades, especially in the young; male with shining blue spots; snout with bright-colored streaks; preopercle strongly serrate; head 3½ in length; depth about 3; D. XIV, 10; A. III, 10.] (*Steindachner*). .... PIRCA, 16.

hh. Scales comparatively large, 3½–31–11; scales on cheeks small, in three or four series; snout 3½ in head (2½ in the adult); eye 5 to 6; color olivaceous, with longitudinal streaks in life; back with five obscure dark cross-bands, which usually extend as two or three blotches on the dorsal fin; one of these usually larger and more distinct than the others; a small dark spot usually present on middle of base of caudal; base of pectoral with a curved, bluish streak, sometimes obsolete; some specimens (males?) with curved, inky streaks on head, and numerous, irregular dark spots sprinkled over the body; others (females?) nearly plain; usually a dark area on preorbital and on preopercle; sometimes a curved streak from eye to chin; vent dark; head 3½ in length; depth 2⅗; D. XV, 9; A., III, 9.... OCELLARIS, 17.

xx. Opercle with a large jet-black blotch, bordered with whitish, and nearly as large as eye; usually a small dark spot at base of caudal; sides sometimes with two or three silvery bands; usually three brownish blotches along base of dorsal extending on the fin and two on anal; vent pale; body elongate-elliptical; the head rather low, with concave profile and short sharp snout (approaching somewhat the form seen in *S. scina*); snout 3⅓ in head; eye 5; head 3; depth 3; D. XIV, 10; A. III, 9; scales 3–33–10.............................. OCELLATUS, 18.

aa. Head notably long and low, its depth at center of eye scarcely half its length and scarcely more than length of snout; premaxillaries extremely protractile, the length of their posterior processes, from tip of upper jaw, more than one-third length of head (*Symphodus* Raf. = *Coricus* Cuvier).

i. Scales 3–30–11; scaly part of cheek not so broad as eye and with three rows of small scales; snout very long, 2¼ in head, the anterior profile being considerably concave; body much compressed, the back elevated; color greenish, with many brown dots and marblings; brown band from snout through eye to middle of sides; vent black; a faint blackish spot at base of caudal; a black spot anteriorly on dorsal fin; dorsal fin with brown dots; a blackish blotch on the first two or three spines; caudal dusky; anal with a dusky shade; head 3; depth 3; D. XV, 10; A. III, 9; scales 3–30–11 .... SCINA, 19.

The use of the above key may, perhaps, be facilitated by the following table of the usual diagnostic marks of the species of *Symphodus*:

Mediterraneus: Large inky blotch on base of pectoral; large dark blotch on upper part of caudal peduncle; caudal speckled.

Tinca: No sharp markings in spirits; diffuse dusky blotch usually present above base of pectoral and another on middle of base of caudal.
Melops: A curved black blotch behind eye and a small one at base of caudal below median line.
Cinereus: A jet black blotch on anterior dorsal spines and another on lower part of base of caudal.
Melanocercus: Tip of caudal blackish; a black spot toward tip of pectoral (rarely absent).
Doderleini: Sides with a brown band edged with silvery, and a small black spot on base of caudal, just above median line; vent black.
Pirca: A large dark spot on last spines and first soft rays of dorsal, a smaller one at base of last ray, and a small one on middle of base of caudal; a dark streak across base of pectoral; scales on cheek large.
Ocellaris: Two to four dark spots along base of soft dorsal; a small one on middle of base of caudal; body deep, covered with large scales; vent dark; body plain (in spirits) or sprinkled with black spots.
Ocellatus: A large inky-black blotch on opercle; a small black spot on middle of base of caudal; vent dark.
Scina: Snout produced, subtubiform; body sprinkled with black specks; vent and spot at base of caudal dark.

The literature of this genus is extremely bad. A large proportion of the nominal species can not be identified with certainty. We have endeavored to refer all these to the species to which they probably belong, but in the case of the species of Rafinesque, and many of those of Brünnich, Walbaum, Risso, and other writers, absolute certainty is impossible. In few cases, however, will the nomenclature be affected by the identification of these useless names.

Besides those mentioned below, the following synonyms we find quoted from a paper which we have not seen: "*Tentamen Ichthyologiæ Melitensis* by Gavinus Gulia, 1861.

Crenilabrus zeraphinus.
Crenilabrus schemberianus.
Crenilabrus dubius.
Crenilabrus serranus.
Crenilabrus serranoides.
Crenilabrus intermedius.
Crenilabrus locaninus.
Crenilabrus propinquus.

10. SYMPHODUS MEDITERRANEUS.

Perca mediterranea Linnæus, Syst. Nat., Ed. x, 291, 1758, and Ed. xii, 485 (Mediterranean Sea); Brünnich, Ichth. Massil., 1768, 66, and of copyists.
Crenilabrus mediterraneus Cuv. & Val., xiii, 186, 1839; Günther iv, 79 (and of most recent authors).
Lutjanus bidens Bloch, Ichthyol., pl. 251, f. 1, 1792.
Labrus purpurescens Bloch and Schneider., Syst. Ichth., 1801, 262 (after Seba, 95, No. 6, t. 31, f. 6.)
? *Lutjanus chlorosochrus* Risso, Ichth. Nice, 1810, 275.
Labrus pittima Rafinesque, Caratteri, etc., 1810, 92.
Crenilabrus boryanus Risso, Europe Mérid., 1826, III, 320.
Crenilabrus nigrescens Risso, l. c., 320.
? *Crenilabrus lapina* et vars. *unicolor* and *fasciatus* Risso, l. c. (*fide* Bonaparte).
Crenilabrus brünnichi Cuv. and Val., xiii, 183 (not of Lacépède).

Habitat.—Mediterranean fauna.

Etymology: Mediterranean.

This abundant species may be known at once by the inky black ocellus on the pectoral fin, a mark which is never absent or even obscure so far as we have noticed. No doubt of any importance exists in connection with its synonymy, the name *mediterraneus* being of unquestioned application and of clear priority. Our specimens are from Venice and Palermo.

11. SYMPHODUS TINCA.

Turdus vulgatissimus tinca marina venetis Willughby, Hist. Pisc., 319, 1686.
? *Alphestes sive Cinædus* Willughby, l. c., 323.
Labrus rostro sursum reflexo, etc., Artedi, Genera 33, Syn. 56 (after Willughby, p. 319).
? *Labrus luteus, dorso purpureo*, Artedi, Syn. 56 (after Willughby, etc.).
Labrus tinca Linnæus, Syst. Nat., Ed. x. 285, 1758, and of the early copyists (after Artedi, 33).
? *Labrus cynædus* Linnæus, Syst. Nat., Ed. x., 288, 1758 (after Artedi, Syn. 56).
Labrus pavo Brünnich, Ichth. Massiliensis, 1768, 49 (not of Linnæus).
Crenilabrus pavo Cuv. & Val. xii, 140; Günther, iv, 78 (and of most recent writers).
? *Labrus corpore fusco*, etc., Brünnich, Ichth. Massiliensis, 1768, 56. No. 72.
? *Labrus fuscus* Gmelin, Syst. Nat., 1788 (after Brünnich); Walbaum, Artedi Piscium, 1792.
? *Labrus lapina* Forskål, l. c., 36 (Constantinople).
? *Labrus serpentinus* Bonnaterre, Encycl. Meth., 1788, 117 (after Brünnich.)
? *Labrus lincki* Bloch, Ichth., iv, 127, taf., 252, 1792.
? *Labrus notatus* Bloch, Ichth., taf., 251, f. 2, 1792.
? *Labrus virescens* Bloch, l. c., taf., 254, 1792.
? *Labrus violaceus* Bloch & Schneider, Syst. Ichth., 1801, 248 (after *Labrus lincki*).
? *Lutjanus brünnichi* Lacépède, Hist. Nat. Poiss., iv, 222, 1803 (after Brünnich).
Lutjanus geoffroyius Risso, Ichth. Nice, 1810, 261, pl. 8, f. 25.
Labrus chrysostoma Rafinesque, Caratteri, etc., 37, 1810.
? *Labrus caliophthalmus* Rafinesque, l. c., 37.
Labrus lappanus Rafinesque, l. c., 39.
Labrus chlorophthalmus Rafinesque, l. c., 40.
? *Labrus marmoratus* Rafinesque, l. c., 41.
? *Lutianus erythrophthalmus* Rafinesque, Indicè, 1810, 67.
Labrus polychrous Pallas, Zoogr, Rosso-Asiatica, 1811, iii, 262.
? *Crenilabrus arcuatus* Risso, Europe Méridionale, 1826, iii, 328.
Labrus fœtidus Chiereghini, p. 123.
Labrus verdutius Chiereghini, p. 124 (fide Canestrini).

Habitat.—Mediterranean fauna.

Etymology: from *tinca*, tench, a fresh-water fish, which these Labroid fishes slightly resemble.

This species is generally abundant in the Mediterranean, and it reaches a larger size (10 or 12 inches) than any of the others. Its synonymy offers no special room for doubt. It is evident, as Valenciennes has shown, that this species is clearly the original of *Labrus tinca* Linnæus, and that it is by no means the original *Labrus pavo* L. Nevertheless all recent writers have called this species *pavo*, and another of the same genus *tinca*, regardless of the confusion which always follows any knowing infraction of the law of priority. If this is the orig-

inal *Labrus tinca* of Linnæus, and of this we see no room for doubt, then it must stand as *Symphodus* or *Crenilabrus tinca*, the other *Crenilabrus tinca* (of Cuv. & Val., 1839), must take some other name, and the name *pavo* must be restored to *Thalassoma* (or *Julis*) *pavo*, to which it has always belonged.

Our specimens of *Symphodus tinca* are from Palermo, and from the south coast of France.

12. SYMPHODUS MELOPS.

Labrus melops Linnæus, Syst. Nat., ed. x, 1758, 286 (southern Europe), and of the copyists.
Crenilabrus melops Cuvier, Règne Animal; Cuv. & Val., xiii, 167; Günther iv, 80; Steindachner, Ichth. Berichte, 1868, 30; Collett, Norges fiske, 92.; Day, British fishes, 260; and of nearly all recent writers.
Labrus rone Ascanius, "Icones, t. xiv, 1772."
Gibbous Wrasse, Pennant, "British Zoology, iii, 250, pl. 47, 1776.
Goldsinny, Pennant, l. c., 251.
Labrus goldsinny Bonnaterre, Encycl. Method, 1788, 112 (after Pennant).
Labrus gibbosus Bonnaterre, l. c., (after Pennant).
Labrus gibbus Gmelin, Syst. Nat., 1788, 1295 (after Pennant).
Labrus cornubicus Gmelin, l., c. 1297.
Lutjanus norwegicus Bloch, Ichth., 256, 1792.
? *Labrus reticulatus* Walbaum, Artedi Piscium, 1792, 236 (after Klein).
Perca maculosa Retzius, "Fauna Suecica, 337, 1800."
Crenilabrus melops et vars. *lugubris* et *superbus* Risso, Eur. Mérid., 1826, fide Bonaparte).
Crenilabrus pennanti Cuv. & Val., xiii, 178, 1839.
Crenilabrus couchi Cuv. & Val., l. c. 1878.
Crenilabrus donovani Cuv. & Val., xiii, 180, 1839.

Habitat.—Coasts of northern Europe; occasionally in the Mediterranean.

Etymology: *Μέλας* black, *ὄψ* eye, from the black spot behind the eye.

This species is found chiefly in the waters of northern Europe, where it is said to be generally common. We have not studied it, and have taken our account of it chiefly from the figure and description of Dr. Day. It is one of the most strongly marked species, and its synonymy offers no special question.

13. SYMPHODUS MELANOCERCUS.

Lutjanus melanocercus Risso, Ichthyol. Nice, 1810, 283.
? *Labrus melanotus* Rafinesque, Caratteri, etc., 1810, 40.
Crenilabrus melanocercus Risso, Eur. Mér., iii, 316, 1826; Cuv. & Val., xiii, 213; Günther, iv, 80; and of all recent authors.
Crenilabrus cæruleus Risso, Eur. Mér., iii, 316, 1826; and of authors.
Crenilabrus cyanospilotus Cocco (fide Bonaparte).
Crenilabrus xanthomelanus Cocco (fide Bonaparte).
Crenilabrus melanoxanthurus Cocco (fide Bonaparte).

Habitat.—Mediterranean fauna.

Etymology: *Μέλας* black, *κέρκος* tail.

We have not seen this species. We follow Dr. Steindachner in regarding *C. cæruleus* as identical with *S. melanocercus*.

14. SYMPHODUS CINEREUS.

Labrus corpore griseo obscurius punctato Brünnich, Ichthyol. Massil., 1768, 58. No. 75.
Labrus cinereus Bonnaterre, Encycl. Meth., 1788, 118 (after Brünnich).
Labrus griseus Gmelin, Syst. Nat., 1788, 1296 (not of Linnæus, nor of Gmelin *op. cit.*, p. 1283, after Brünnich).
Crenilabrus griseus Günther, iv, 83; and of most recent writers.
Labrus rubellio Walbaum, Artedi Piscium, iii, 1792, 264 (after Brünnich).
? *Labrus bicolor*, Bloch & Schneider, Syst. Ichth., 1801, 267 (after Seba).
Labrus fuscus Pallas, Zoogr. Ross.—Asiat., iii, 1811.
Crenilabrus fuscus Cuv. & Val., xiii, 219.
? *Labrus frenatus* Pallas, l. c., 270.
? *Labrus simus* Pallas, l. c., 271.
Lutjanus massa Risso, Ichth. Nice, 1810, 274.
Crenilabrus cottæ Cuv. & Val., xiii, 204 (not *Lutj., cotta* Risso).
? *Labrus fucii* Rafinesque, Caratteri, etc., 38, 1810.
? *Labrus lappanoides* Rafinesque, l. c., 39.
Crenilabrus staiti Nordmann, Demidoff's Reise, iii, 1840, 452.
Crenilabrus pusillus Nordmann, l. c., 454.

Habitat.—Mediterranean fauna and neighboring coasts.

Etymology: *Cinereus*, color of ashes.

This species is generally abundant in the Mediterranean. We have specimens from Venice and Palermo.

The names *Labrus cinereus* Bonnaterre and *Labrus griseus* Gmelin were given simultaneously to this species, and we can not find which of the two is the earlier. The name *Labrus griseus* is, however, inadmissible, because there was an earlier *Labrus griseus* Linnæus (= *Lutjanus griseus*). On an earlier page of Gmelin's work we find this *Labrus griseus* also, the compiler, Gmelin, with characteristic carelessness, not having noticed the duplication of the name *griseus*.

In all our specimens of this species, the dark spot on the front of the dorsal and that on the lower side of the caudal peduncle are very conspicuous.

15. SYMPHODUS DODERLEINI.

Crenilabrus tinca Cuv. & Val. xiii, 199 (probably not *Labrus tinca* L., nor of Brünnich; probably not *Lutjanus tinca* Risso; these being probably *S. scina.*)
Crenilabrus tinca Günther, iv, 86; Canestrini, Labroidés del Mediterraneo, 1868, 31, with an excellent figure.
Symphodus doderleini Jordan (nom. sp. nov.).

Habitat.—Mediterranean fauna and coasts of southern Europe.

Etymology: named for Pietro Doderlein, professor of zoology in the University of Palermo.

This species seems to be rather rare in the Mediterranean, and among the many nominal species, we find none which seem to have been based on it. It is evidently the *Crenilabrus tinca* of Cuv. & Val., their description according perfectly with our specimens. It is also apparently the *Crenilabrus tinca* of Steindachner, Vinciguerra and Doderlein. The description of Günther applies well to our specimens. Günther

does not, however, describe the form of the head, and we are informed by Mr. G. A. Boulenger that in the specimens in the British Museum the form of the head is much as in *Coricus rostratus* (*Symphodus scina*). We do not think that the *Labrus tinca* either of Risso or of Brünnich can be our species. Their descriptions apply better to *Symphodus scina* which also has the vent black, and which is green, without distinct lateral bands. Our species is, of course, not the *Labrus tinca* of Linnæus, and it can not retain the specific name of *tinca*.

We have given to it the new name of *Symphodus doderleini*, in honor of our excellent friend Prof. Pietro Doderlein of the University of Palermo.

The numerous specimens in our possession were sent by the museum at Paris, and probably came from the neighborhood of Marseilles.

16. SYMPHODUS PIRCA.

Labrus species, Dalmatinis *Pirca*, etc., Brünnich, Ichth. Massiliensis, 97, 1768.
Labrus pirca Walbaum, Artedi Piscium, 1792, 265 (after Brünnich).
Crenilabrus bailloni Cuv. & Val. xiii, 191, 373, 1839; Günther iv, 84; and of recent writers.

Habitat.—Mediterranean fauna.

Etymology: *Pirca*, a Dalmatian name, a corruption of the Latin *perca*, perch, from Πέρκη, derived by Rondelet from Περκαίνων to be of diverse colors.

We have not seen this species, which seems to be rather rare in the Mediterranean. The description given by Brünnich of his *Labrus* called *Pirca* in Dalmatia, and which he thinks may be a variety of his No. 73 (*S. cæruleovittatus*), agrees very closely with this species. We have therefore substituted the name "*pirca*" for "*bailloni*." Faber gives "*Spirca*" as the Dalmatian vernacular name for *S. melops*.

17. SYMPHODUS OCELLARIS.

? *Labrus ocellaris* Linnæus, Syst. Nat., Ed. x, 1758, 285.
Labrus tinca Brünnich, Ichth. Mass. 55, No. 70 (and of Risso, 1810, not of Linnæus).
? *Labrus corpore olivaceo lineato, pinna dorsali postice unimaculata*, Brünnich, Ichthyol. Massil., 1768, 57, No. 73.
Labrus corpore rubescente nigro vario, Brünnich, Ichthyol. Massil. 1768, 59, No. 76.
Labrus cæruleovittatus Bonnaterre, Encycl. Meth., 1788, 117 (after Brünnich, No. 73).
Labrus unimaculatus Gmelin, Syst. Nat., 1788, 1295 (after Brünnich, No. 73).
Labrus guttatus Bonnaterre, Encycl. Meth., 1788, 118; Gmelin, Syst. Nat., 1788, 1296 (after Brünnich, No. 76).
Labrus erithrophthalmus Walbaum, Artedi Piscium, 1792, 263 (after Brünnich, No. 73).
? *Labrus garcetto* Walbaum, Artedi Piscium, 1792, 250 (after Seba).
Labrus quinquemaculatus Bloch, Ichthyol., taf., 291, 1792.
Crenilabrus quinquemaculatus Günther, iv, 82; and of most recent writers.
? *Labrus flavescens* Bloch & Schneider, Syst. Ichth., 1801, 260 (after Seba.).
Labrns rubens Bloch & Schneider, Syst. Ichth., 1801, 256 (after Brünnich, No. 76).
Labrus massiliensis Lacépède, iv, 222, 1803 (after Brünnich, No. 73).
Lutjanus roissali Risso, Ichth. Nice, 1810, 276.
Crenilabrus roissali Cuv. & Val., xiii, 205; and of authors.

Lutjanus alberti Risso, l. c., 277.
Lutjanus varius Risso, l. c., 277.
Lutjanus cotta Risso, l. c., 282.
Labrus oculis-perdix Rafinesque, Ichth. Oh., 1810, 39.
Crenilabrus tigrinus Risso, Eur. Mérid., iii, 317, 1826 (and varieties *semimaculatus* and *rubiginosus*) (fide Bonaparte).
Labrus æruginosus Pallas, Zoogr. Rosso-Asiat., iii, 1811, 264.
Labrus capistratus Pallas, l. c., 269.
?? *Crenilabrus aurantiacus* "Cocco."

Habitat.—Mediterranean fauna.

Etymology: *Ocellaris*, having an eye-like spot.

This brilliant little fish seems to be abundant in the Mediterranean. Our specimens are from Palermo. Its great variations in color have given it a long and complicated synonymy, and even the question as to which is its oldest name must remain unsettled.

Labrus ocellaris L. may be this species, but of this there can be no certainty. The description only shows that the species is a *Symphodus*, and that it has a black spot at the middle of the base of the caudal. It is very likely a female of the present species, for the female of this species is probably the only one with a black spot at the middle of the base of the caudal and no distinct markings elsewhere. We have, however, hesitated to adopt the name *Symphodus ocellaris* for the present species, as Linnæus' fish might possibly have belonged to *S. rostratus* or possibly to *S. tinca.* It is certain that Brünnich's No. 76 belonged to the present species, and scarcely less certain that this is his No. 73 also.

In the year 1788 Bonnaterre gave to this Brünnich's No. 73 the specific name of *cœruleovittatus*, and to No. 76 a page later the name of *guttatus.* In the same year Gmelin called No. 73 *Labrus unimaculatus*, and No. 76 also *Labrus guttatus.* If the name *ocellaris* be set aside as unidentifiable we must then choose between *Labrus cœruleovittatus* of Bonnaterre and *Labrus unimaculatus* of Gmelin. We are unable to find which of these two works, both now a century old, has priority. Neither writer mentions the other. Gmelin's preface is dated March 16, 1788, while the page devoted by Bonnaterre to the "Privilege du Roi," or copyright, bears date of May 16, 1788. Bonnaterre states that there have been thirteen editions of the Systema Naturæ, and Gmelin's edition is styled the thirteenth, but there is no evidence that he had seen or used the thirteenth edition, or that the latter had appeared when his own work was published. Most likely the two works were nearly simultaneous in their appearance, a very slight probability lying in favor of Gmelin, whose preface was written two months before Bonnaterre obtained his privilege of publication. On the other hand, Bonnaterre's name for the present species is much preferable to Gmelin's, which is irrelevant and misleading. A little later in date is Bloch's name, *quinquemaculatus*, lately brought into use by Dr. Günther. This name is scarcely preferable to *unimaculatus*, and the figure of Bloch is a caricature, though it can not refer to any other species. In any case

other well-identified names are prior to *quinquemaculatus*. The other synonyms need no special discussion.

For the present we may use for this species the name of *Symphodus ocellaris*, which in all probability belongs to it, and as no absolute certainty would accompany the use of any of the other names.

18. SYMPHODUS OCELLATUS.

Labrus corpore viridi-olivaceo operculorum apice cœruleo Brünnich, Ichth. Mass., 56, No. 71, 1768.
Labrus viridis venis rubris anastomosantibus Brünnich, l. c., 58, No. 74, 1768.
Labrus ocellatus Forskål, Descr. Anim., 37, 1775 (Smyrna).
Crenilabrus ocellatus Cuv. & Val., xiii, 193; Günther, iv, 85; and of authors generally.
Labrus olivaceus Bonnaterre, Encycl. Meth., 1788, 117 (after Brünnich, No. 71, and of Gmelin, Walbaum, etc.).
Labrus reticulatus Bonnaterre, l. c., 117 (after Brünnich, No. 74).
Labrus venosus Gmelin, Syst. Nat., 1296, 1788 (and of Walbaum), (after Brünnich, No. 74).
Labrus mendovella Rafinesque, Indice all' Ittiol. Sicil., 1810, 54.
Lutianus ruber, Rafinesque, l. c., 63.
Labrus perspicillatus Pallas, Zoogr. Rosso-Asiat., 1811, 267.
Crenilabrus littoralis Risso, Eur. Mérid, iii, 232, 1826.
Crenilabrus rissoi Cuv. & Val., xiii, 197, 1839.
Crenilabrus morelli Nordmann, "Demidoff's Réise, 459, 1840."
Crenilabrus argentostriatus Nordmann, l. c., 461, 1840.

Habitat.—Mediterranean fauna.

Etymology: *Ocellatus*, having an eye-like spot.

This handsome little fish seems to be rather common in the Mediterranean. Our specimens are from Palermo. Its variations in color are great, but the jet black opercular ocellus is always diagnostic. Its synonymy is long, but none of it seems to admit of doubt and the name *ocellatus* has clear priority over all others.

19. SYMPHODUS SCINA.

Labrus scina Forskål, Descr. Anim., 1775, 36 (Constantinople), (and of the copyists).
Lutjanus rostratus Bloch, Ichthyol., taf. 254, f. 2, 1792.
Coricus rostratus Cuv. & Val. xiii, 256, pl. 376; and of numerous authors.
Crenilabrus rostratus Günther iv., 86; and of numerous recent authors.
Lutjanus rubescens Risso, Ichth. Nice, 271.
Lutjanus virescens Risso, Ichth. Nice, 280 (not of Bloch).
Lutjanus lamarcki Risso, l. c., 281.
? *Labrus pittimoides* Rafinesque, Caratteri, etc., 1810, 36.
Labrus verdolidus Rafinesque, l. c., 36.
Labrus macrostomus Rafinesque, l. c., 36.
Symphodus fulvescens Rafinesque, l. c., 41.
Coricus brama Nordmann, Demidoff's Reise, 1840, 464.
Coricus fasciatus Cocco (*fide* Bonaparte).

Habitat.—Mediterranean fauna.

Etymology: *Σκίνα*, Greek name for the species at Constantinople, perhaps from σκίναξ, nimble.

This curious little fish seems to be very common in the Mediterranean. Our numerous specimens are from Venice, Palermo, and southern France. No special doubt seems to exist in regard to its synonymy, the name *scina*, clearly belonging to it, having priority over the generally received specific name *rostratus*.

Genus V.—CTENOLABRUS.

Ctenolabrus Cuvier & Valenciennes, Hist. Nat. Poiss., xiii, 223, 1839, (*rupestris* = *suillus*).
Tautogolabrus Günther, Cat. Fish, Brit. Mus., iv, 89, 1862 (*burgall* = *adspersus*).
Lappanella Jordan, subgenus nova.

TYPE: *Labrus rupestris* L. = *Labrus suillus* L.

Etymology: *Κτείς* comb, from the serrated preopercle; *Labrus*, an allied genus.

This genus contains four species, distinguished from the species of *Symphodus* by having the teeth in the jaws in two series anteriorly, there being a series of smaller teeth behind the canines. The known species diverge considerably from each other, and each of the three best known may be the type of a distinct subgenus. The first of these groups approaches very closely to the subgenus *Symphodus* of the preceding genus.

ANALYSIS OF SPECIES OF CTENOLABRUS.

a. Snout long and sharp, low, horizontally produced, the depth of the head at the eye not half the length of the head; inner series of teeth small. (*Lappanella*, Jordan.)

b. [Body elongate, the greatest depth 4 in length, the head $3\frac{1}{2}$; back somewhat elevated, the anterior profile somewhat concave; snout a little longer than eye, which is 4 in head; cheeks not broader than eye, provided with about four rows of scales; scales on body large; interopercle scaly; dorsal spines rather high; color scarlet; a brown band backward from eye to gill-opening; a large black blotch on the front of the soft dorsal, one on the tail at the base of caudal, near the upper margin, one on the upper rays of caudal, and one near the tip of the middle rays. D. XVI, 11; A. III, 10; scales 3–37–10.] (*Cuv. & Val.*) ....IRIS, 20.

aa. Snout not specially elongated or depressed, the depth of the head at the eye not less than half its length; scales smaller; vertebræ probably more numerous (33 to 36).

c. Interopercle scaly (European species) (*Ctenolabrus*).

d. [Body moderately robust, the depth about $3\frac{2}{3}$ in length, the head $3\frac{1}{2}$; snout rather pointed, the anterior profile being nearly straight; eye $3\frac{3}{4}$ in head, rather shorter than snout; mouth small, the maxillary not reaching front of eye; cheeks with six rows of scales; dorsal spines low, lower than the soft rays; color golden or pinkish, darker above; fins reddish; a dark blotch along front of spinous dorsal, another at upper base of caudal; body sometimes with a short, pale lateral stripe, sometimes with dusky cross-bands. D. XVII, 10; A. III, 8; scales 4–40–15; vertebræ 15 + 18 = 33.] (*Day.*)..............................SUILLUS, 21.

cc. Interopercle wholly naked (American species), (*Tautogolabrus* Günther).

e. Scales rather small, about 46 in the lateral line; body rather robust, the depth 3 in length; the head $3\frac{1}{2}$; snout short, not very sharp; eye shorter than snout $4\frac{1}{2}$ in head; cheeks with small scales, in 5 rows; dorsal spines low and pungent; color livid blue, shaded with brownish above and with more or less of a brassy luster on sides; head and back sometimes spotted with brassy; young with darker blotches and markings, and often a black blotch near middle of dorsal fin. D. XVIII, 10; A. III, 9; scales 6–46–17; vertebræ 17 + 19 = 36.
ADSPERSUS, 22.

ee. [Scales rather large, 37 or 38 in the lateral line; head about $4\frac{1}{4}$ in total length; depth $3\frac{2}{5}$; eye $4\frac{2}{3}$ in head; scales on cheeks in 5 rows; middle of the opercle scaly, the last row of smaller scales, and falling almost wholly on the subopercle; preopercle finely serrate, interopercle scaleless; color of body golden brown, paler below; soft dorsal and anal regularly dotted with small brown spots; scales of upper part edged with dark brown; D. XIX, 9; A. III, 9; scales 5 or 6–37 or 38–14.] (*Steindachner.*) .... BRANDAONIS, 23.

20. CTENOLABRUS IRIS.

LAPPANELLA.

Ctenolabrus iris Cuv. & Val., xiii, 236, pl. 374, 1839 (Naples; Sicily; Malta); Günther iv, 90 (Sicily); and of authors.

Habitat.—Mediterranean.

Etymology: *Iris*, rainbow.

We have not studied this species. It has evidently affinities with *Symphodus rostratus*, and excepting in its dentition it resembles *Symphodus* rather than the more boreal species which are typical of *Ctenolabrus*.

21. CTENOLABRUS SUILLUS.

Labrus suillus Linnæus, Syst. Nat. Ed. x, 1758, 285 (West Gotha); and of copyists.
Labrus rupestris Linnæus, Syst. Nat., l. c., 286; and of copyists.
Ctenolabrus rupestris Cuv. & Val., xiii, 223; Günther, iv. 89; Steindachner, Ichth. Ber., 1868, 32; Day, British Fishes, 264; and of most recent writers.
Sparus carudse Lacépède, iv, 148, 1803 (after *Labrus rupestris* L.).
Labrus cinereus Pallas, Zoog. Rosso-Asiat., iii, 267, 1811.
Ctenolabrus marginatus Cuv. & Val., xiii, 232, 1839.
Ctenolabrus acutus Cuv. & Val., xiii, 235, 1839.

Habitat.—Coasts of Europe, especially northward; rare in the Mediterranean.

Etymology: *Suillus*, belonging to swine.

We have not studied this species, which is one of the common fishes of northern Europe, reaching a length of 6 inches. Of the two Linnæan names for this species that of *Labrus suillus* has, unfortunately, the priority of a page.

22. CTENOLABRUS ADSPERSUS (Plate I, fig. 1).

CUNNER; CHOGSET; BERGALL; BLUE PERCH.

Labrus burgall Schœpf, Gesellsch. Naturf. Freunde, viii, 155, 1788 (New York).
Labrus adspersus Walbaum, Artedi Piscium, 254, 1792 (after Schœpf).

Tautogolabrus adspersus Bean, Proc. U. S. Nat. Mus., 1880, 87 (Wood's Holl, Gloucester, and Provincetown, Mass.; Portland, Me.; Noank, Conn.).
Ctenolabrus adspersus Stearns, Proc. U. S. Nat. Mus., 1883, 123 (Cape Britain); Jordan & Gilbert, Syn. Fishes N. Am., 599, 1883; Goode, Nat. Hist. Aquat. Anim., 273, 1884.
Tautoga niger Mitchill, Rep. (in part) on the Fishes of New York, 23, 1814 (New York); Cuv. & Val., xiii, 293, 1839 (New York).
Tautoga cœrulea Mitchill, Rep. (in part) on the Fishes of New York, 24, 1814 (New York).
Ctenolabrus ceruleus Dekay, New York Fauna, Fishes, 172, pl. 29, f. 93, 1842.
Labrus chogset Mitchill, Trans. Lit. and Phil. Soc. N. Y., i. 402, pl. 3, f. 2, 1815 (New York).
Labrus chogset fulva Mitchill, l. c., 403, 1815.
Ctenolabrus chogset Cuv. & Val., xiii, 237, 1839 (New York; Newfoundland).
Crenilabrus burgall Storer, Fishes of Mass., 78, 1839; Ayres, Bost. Jour. Nat. Hist., iv, 263, 1842 (Brookhaven).
Ctenolabrus burgall Günther, iv, 90, 1862 Canada; Boston; Nahant Bay).
Ctenolabrus uninotatus Cuv. & Val., xiii, 239, 1839 (New York); Dekay, New York Fauna, Fishes, 174, pl. 29, f. 90, 1842; Günther, iv, 90, 1839 (Halifax).

Habitat.—Atlantic coasts of North America, from Labrador to New York.

Etymology: *Adspersus*, speckled (besprinkled).

This little fish is exceedingly abundant about rocks and wharves near shore in the regions where it is found. It reaches a length of about 10 inches, being too small to have much value as food, although its flesh is of excellent flavor. These fishes, although performing a useful duty as scavengers, are a pest to the fishermen from their habit of nibbling the bait from their hooks.

23. CTENOLABRUS BRANDAONIS.

Ctenolabrus (*Tautogolabrus*) *brandaonis* Steindachner, Ichth. Notiz., iv, 16, 1867 (Brazil).

Habitat.—Coast of Brazil.

Etymology: Personal name unexplained.

This species is known from Dr. Steindachner's description only. It would be interesting to know in what part of Brazil it was found, as it is not of the type of Labroids usually found in the tropics.

Genus VI.—HIATULA.

Hiatula Lacépède, Hist. Nat. Poiss., ii, 522, 1800 (*hiatula=onitis*).
Tautoga Mitchill, Hist. Fish. N. Y., 1814, 23 (*tautoga=onitis*).
Hiatula Jordan, Proc. U. S. Nat. Mus., 1882, 571.

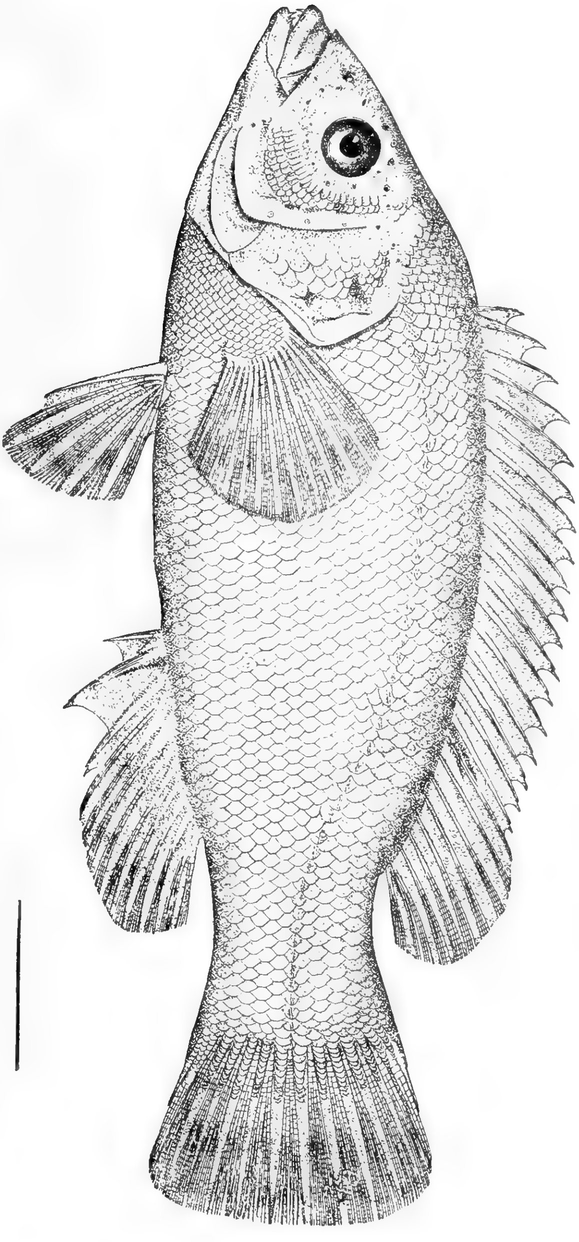
TYPE: *Labrus hiatula* L. = *L. onitis* L.

Etymology: *Hiatula*, an old Latin name of *Serranus cabrilla*, from *hiatus*, a gaping.

This genus contains a single species, a large, dull-colored labroid, abundant on the Atlantic coast of the United States.

a. Body somewhat deep and compressed; the head about $3\frac{1}{2}$ in length; depth $2\frac{2}{3}$; eye rather small, about 5 in head; caudal truncate or very slightly rounded; snout rather blunt; the profile moderately steep; a patch of small scales behind

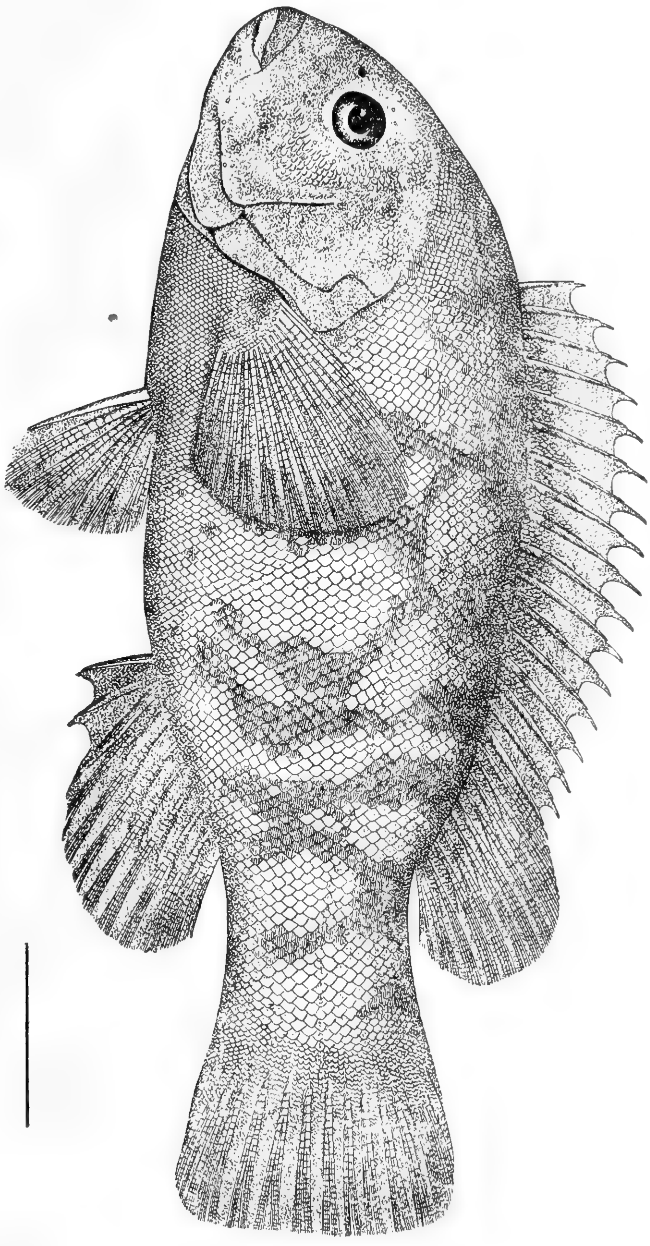
PLATE I.



CTENOLABRUS ADSPERSUS Walbaum. Cunner; Chogset.

(No. 17741, U. S. N. M.; from Wood's Holl, Massachusetts.)

PLATE II.



HIATULA ONITIS Linnæus. Tautog; Blackfish.
(No. 17738, U. S. N. M.; from Wood's Holl, Massachusetts.)

eye extending downward to middle of cheek, where there are five or six series; pectorals $4\frac{1}{2}$ in length; color blackish or greenish; the young usually with about three pairs of dark bars connected by reticulations; adult often nearly plain blackish; chin white; D. XVI, 10; A. III, 8; Lat. l. 60 .... ONITIS, 24.

24. HIATULA ONITIS. (PLATE II.)

(TAUTOG; BLACKFISH; OYSTER-FISH.)

Labrus onitis Linnæus, Syst. Nat., ed. x, 286, 1758; ed. xii, 478, 1766 (habitat unknown) and of the copyists.

Tautoga onitis Günther, iv, 88, 1862 (Boston; New York; Beesley's Point); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 374 (Beaufort, N. C.); Bean, Proc. U. S. Nat. Mus., 1880, 87 (Wood's Holl, Mass.; Noank, Conn.; Massachusetts Bay); Jordan & Gilbert, Syn. Fishes N. Am., 600, 1883; Goode, Nat. Hist. Aquat. Anim., 268, 1885.

Hiatula onitis Jordan & Gilbert, Syn. Fishes N. Am., 600, 1883; Jordan, Proc. U. S. Nat. Mus., 1886, 28 (Beaufort, N. C.).

Labrus hiatula Linnæus, Syst. Nat., ed. xii, 475, 1766 (Carolina); Jordan, Proc. U. S. Nat. Mus., 1885, 396 (note on Linnæus' type).

Hiatula hiatula Goode & Bean, Proc. U. S. Nat. Mus., 1885, 201 (note on type of *Labrus hiatula*).

Labrus carolinus Bonnaterre, Tableau Enclycloped. et Method., Ichthyologie, 113, 1788 (Carolina), (after Linnæus).

Labrus, Blackfish, Schœpf, Schrift der Gesellsch. Natur. Freunde, viii, 156, 1788 (New York).

Labrus subfuscus Walbaum, Artedi Piscium, 254, 1792 (after Schœpf).

Labrus tessellatus Bloch, Ichthyologie, taf. 291, 1792 ("Norway").

Tautoga tessellata Cuv. & Val., xiii, 315, 1839 (after Bloch).

Hiatula gardiniana Lacépède, Hist. Nat. Poiss, ii, 522, 1800 (after *L. hiatula* Linnæus).

Labrus americanus Bloch & Schneider, Syst. Ichth., 261, 1801 (after Schœpf); Ayres, Bost. Journ. Nat. Hist., iv, 263, 1842 (Brookhaven; Sag Harbor; Greenport; Gardiner's Bay, Long Island).

Tautoga americana Storer, Hist. Fish. Mass., 276, 1867 (Plymouth; Lynn; Boston; Wellfleet); Dekay, New York Fauna, Fishes, 175, pl. xiv, f. 39, 1842 (New York).

Labrus tautoga Mitchill, Trans. Am. Phil. Soc., 399, 1815 (Long Island; Rhode Island; Cape Cod; Sandy Hook).

Labrus tautoga fusca Mitchill, Trans. Am. Phil. Soc., 402, 1815.

Labrus tautoga rubens Mitchill, Trans. Am. Phil. Soc., 402, 1815.

Labrus tautoga alia, l. c., 402, 1815.

Habitat.—Atlantic coasts of the United States, from Cape Ann to Charleston.

Etymology: Ὀνίτις, a kind of plant; application unexplained.

The tautog is one of the most valuable food fishes of the Atlantic coast. It is generally abundant within its range, and its flesh is of superior quality. The largest specimen known, according to Professor Goode, has a length of about 3 feet.

It is probable that this is the *Labrus onitis* of Linnaeus, but the description is too incomplete to permit absolute certainty of identification.

Genus VII.—LACHNOLAIMUS.

Lachnolaimus Cuvier & Valenciennes, Hist. Nat. Poiss., xiii, 274, 1839 (*aigula* = *maximus*).

Lachnolæmus Jordan & Gilbert, Syn. Fishes N. Am., 600, 1883 (amended orthography).

TYPE: *Lachnolaimus aigula* C. & V.=*Labrus maximus* Walbaum.

Etymology: *λάχνος*, wooly; *λαιμός*, throat, part of the surface of the pharyngeals being covered with a velvety membrane.

This genus contains a single species, a large, showy fish of tropical America, remarkable for the long streamer-like filaments on the dorsal spines.

ANALYSIS OF SPECIES OF LACHNOLAIMUS.

a. Body deep, strongly compressed, the back much elevated, the profile long and steep; snout sharp; canine teeth prominent; filamentous dorsal spines reaching to last rays of soft dorsal. Color reddish gray, varying to brick red; some of the scales olive-green at base, cheeks greenish, head mottled; a large round blue-black blotch at base of last rays of soft dorsal; caudal grayish, with three rows of dull olive spots; anal similarly colored; an undulate blue line below eye; deep-water fishes brick-red or orange red; adult male with vertical fins blackish at base, the black forming a crescent on the caudal; frontal region from snout to occiput abruptly blackish; head 3 in length; depth $2\frac{1}{3}$; D. XIV, 11 or 12; A. III, 11. Lat. l. 39..MAXIMUS, 25.

25. LACHNOLAIMUS MAXIMUS. (PLATE III.)

(HOG FISH; CAPITAINE; PERRO PERRO.)

Suillus (The Great Hog Fish) Catesby, Nat. Hist. Carolina, pl. 15, 1750.

Labrus maximus Walbaum, Artedi Piscium, 261, 1792 (after Catesby).

Lachnolæmus maximus Jordan, Proc. U. S. Nat. Mus., 1884, 546; Jordan, l. c., 1886, 45 (Cuba).

Lachnolaimus suillus Cuvier, Règne Animal, Ed. ii, 1829 (after Catesby); Cuvier and Val., xiii, 286, 1839 (Saint Thomas); Poey, Enumeratio, 105, 1875 (Havana); Bean & Dresel, Proc. U. S. Nat. Mus., 1884, 153 (Jamaica); Jordan, l. c., 134 (Key West.)

Lachnolaimus aigula Cuv. & Val., xiii, 277, 1839 (St. Bartholomew).

Lachnolaimus dux Cuv. & Val., xiii, 285, 1839 (Martinique).

Lachnolaimus caninus Cuv. & Val., xiii, 288, 1839 (St. Thomas; San Domingo); Poey, Synopsis, 330, 1868 (Havana).

Lachnolaimus psittacus Cuv. & Val., xiii, 291, 1839 (Porto Rico).

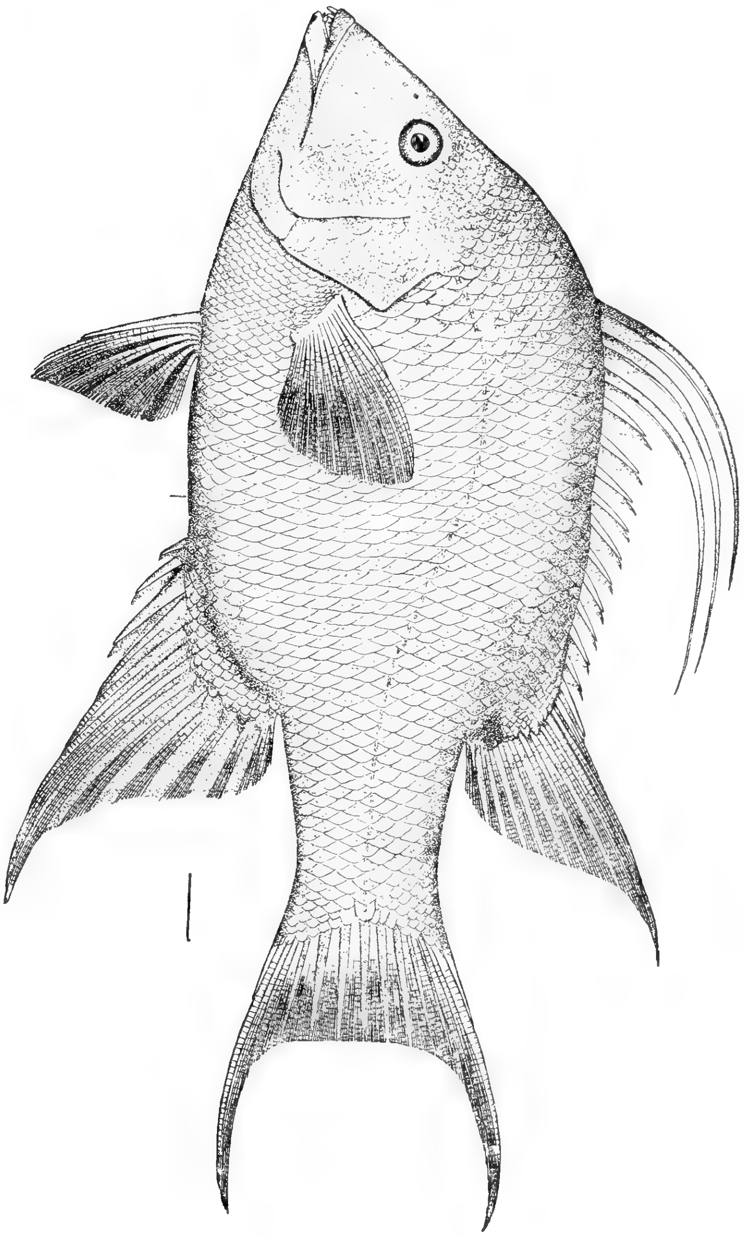
Lachnolaimus falcatus Günther, iv, 87, 1862 (Cuba; Jamaica; Puerto Cabello) (after *Labrus falcatus L.*, but the Linnæan *falcatus* is probably a *Trachinotus*); Goode, Bull. U. S. Nat. Mus., v, 1876, 36 (Bermudas); Goode, Nat. Hist. Aquat. Anim., 1885, 275 (Key West); Jordan & Gilbert, Syn. Fishes N. Am., 601, 1883; Stearns, Nat. Hist. Aquat. Anim., 275, 1885; Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 134 (Key West).

Habitat.—West Indies, north to Key West.

Etymology: *Maximus*, largest.

This large and showy species is generally common in the West Indies. It reaches sometimes a weight of 12 to 15 pounds, and is generally es-

PLATE III.



LACHNOLAIMUS MAXIMUS Walbaum Hog Fish; Capitaine.

teemed as a food fish. It changes much in the course of its growth, and it has thus received several specific names. The oldest binomial name is that of *Labrus maximus* Walbaum, based on the Great Hog Fish of Catesby. The *Labrus falcatus* of Linnæus is doubtless a species of *Trachinotus*.

Genus VIII.—HARPE.

Bodianus Bloch, Ichthyol., iv, 33, 1790 (in part; not as restricted by Cuvier).

Harpe Lacépède, Hist. Nat. Poiss., iv, 426, 1802 (*cæruleo-aureus* = *rufus*).

Cossyphus Cuvier & Valenciennes, xiii, 102, 1839 (*bodianus*=*rufus*) (name pre-occupied in *Coleoptera* and in birds).

Crenilabrus Swainson, Nat. Hist. Class'n Fishes, ii, 1839 (*verres* = *rufus*) (not of Cuvier).

? **Lepidaplois** Gill, Proc. Acad. Nat. Sci. Phila., 1862, 140 (*axillaris*; species with the dorsal fins low, not falcate, the preoperclar limb scaly, the snout produced).

? **Euhypsocara** Gill, op. cit., 1863, 222 (*anthioides*; dorsal and anal not falcate; limb of preopercle scaly, snout short).

? **Gymnopropoma** Gill, op. cit., 1863, 222 (*bilunulata*; as in the last, but limb of preopercle naked).

Harpe Gill, l. c., 1863, 222 (*bodianus*; soft dorsal and anal falcate).

? **Achœrodus** Gill, op. cit., 1863, 222 (*gouldi*; species without posterior canine, and with the scales smaller than usual; lat. l. 39; probably a distinct genus).

Bodianus Poey, Rep. Fis. Nat. Cuba, ii, 331, 1867 (*bodianus*).

TYPE: *Harpe cœruleo aureus* Lacépède = *rufus L.*

Etymology: Ἅρπη, scythe, in allusion to the falcate fins.

The genus *Bodianus*, as originally constructed, was a most heterogeneous assemblage of species, having only the supposed common character of the head naked anteriorly, the preopercle entire, and the opercle spinous. Most of the species originally included are Serranoid fishes. The name, however, was taken from the species called *Bodianus bodianus*. The word *bodianus* is the Portuguese *Bodiano*, or rather *Pudiano*, a name still used in Brazil for various Labroid fishes. For this reason the name *Bodianus* has been taken by Gill and Poey for this group instead of using it for the Labroid genus *Enneacentrus* or *Cephalopholis*, to which it was restricted by Cuvier. It seems to me that the first restriction must hold. The name *Harpe*, an euphonious and appropriate one, comes next in order of time and may be used instead of *Cossyphus*. The latter name has been in general use, although it has been twice used before its application to these fishes. All of the American species of *Harpe*, in fact all the American *Harpinæ*, have the soft parts of the dorsal and anal fins produced in angular lobes, and often in long streamers. This is true of few or none of the Old World species, which are also somewhat different in squamation and in the form of the head. It is probable that Gill is right in separating these from *Harpe* to form the genus *Lepidaplois*. Of the later subdivisions of *Lepidaplois*, *Achœrodus* will perhaps prove to represent a different genus, but the value of the characters used to distinguish *Euhypsocara* and *Gymnopropoma* can not be very great.

ANALYSIS OF SPECIES OF HARPE.

Common characters.—Body rather robust, somewhat compressed, covered with large scales; cheeks, opercles, and interopercle scaly; preopercle serrulate, usually becoming entire with age; mouth rather large, the anterior canines $\frac{4}{4}$, the median canines of the lower jaw usually smallest; posterior canines present; a scaly sheath at base of both dorsals; angles of caudal, and of soft dorsal and anal fin more or less produced, especially in the adult; median caudal rays subtruncate; depth in the adult about equal to length of the head. D. usually XII, 11 (rarely XIII, 10); A. III, 13; lat. l, usually 33.

a. Male, in life, blue, with a yellow patch behind the pectoral fin, which has a large dark spot on its extremity; head, tail, and fins bright red, their tips black and yellow; forehead very gibbous in the adult, preopercle entire, or very slightly crenulated; eye a little less than 6 in head, which is about $3\frac{1}{3}$ in length; all the fins (except the pectorals) elongate in the adult, the dorsal nearly reaching and the anal extending beyond the median caudal rays; external caudal rays twice as long as the median; ventrals reaching nearly to base of anal.

Females: Color brownish-yellow; a dark band commences behind the snout and is divided into two behind the eye, the upper portion running along the back and nearly joining its fellow from the other side on the back of the free portion of the tail, while the lower crosses the angle of the operculum and is continued on to the middle of the tail, terminating near the caudal and alternating with two spots behind the base of the caudal fin; fins yellowish or orange. Forehead scarcely gibbous in the adult; preopercle entire or slightly crenulated; eye 6 in head, which is about equal to depth; vertical fins elongate in the adult, the dorsal extending nearly to and the anal beyond the median caudal rays, which are one-half as long as the external rays; ventrals extending to the third anal spine. Depth (including scaly dorsal sheath) nearly $3\frac{1}{2}$ in length; D. XII, 11; A. III, 13; scales 5–33–12 .... DIPLOTÆNIA, 26.

aa. Color chiefly red, without dark bands or stripes.

b. Pectorals immaculate.

c. Body without dark cross band, or conspicuous pale blotch.

d. General color violet-red above and anteriorly, yellow or orange behind and below; lower part of sides and posterior part of body yellowish-orange; upper part of head and body (as far back as a line joining base of pectoral and soft dorsal) violet-red; middle of caudal, bases of pectorals and ventrals, and most of anal violaceous. Head $3\frac{1}{2}$ in length; depth nearly 3. D. XII, 9; A. III, 11 or 12; scales 5–32–13; fins a little less produced than in *H. pectoralis* .... RUFA, 27.

dd. [General color vermilion, with two large, irregular, black blotches on the back and dorsal fin, the anterior on the first six dorsal spines, the posterior extending over the whole soft dorsal and over a portion of the back of the tail; snout pointed, with the upper profile slightly concave; head longer than high; dorsal and anal fins produced; caudal emarginate. D. XII, 10; A. III, 12; Lat. l, 32.] (Valenciennes.) .... ECLANCHERI, 28.

cc. [Body with a dark-brown cross band before with a pale blotch under soft dorsal; snout pointed, less than 3 in head, eye nearly 7; scales on cheek small, in eight series; dorsal spines increasing in length posteriorly, the first being rather shorter than the eye, the last as long as the ventral spine, which is $2\frac{2}{3}$ in head; produced rays of soft dorsal and anal not reaching root of caudal; color unknown, probably red; a large whitish blotch below the soft dorsal; a blackish cross-band in front of this blotch, descending from the ninth, tenth, and eleventh dorsal spines. Head equal to depth of body and 3 in total; D. XIII, 10; A. III, 12; scales 5–33–12.] (Günther.)
TREDECIMSPINOSA, 29.

bb. [Pectorals with a large dark-blue spot towards the tip; color carmine-red, fins edged with darker; base of pectoral whitish; side of body with a pale rose-colored band; dorsal fin low; ventrals reaching vent; snout sharp; length of head equal to depth of body, which is 4⅘ in total length; D. XII, 9; A. III, 12.] (Poey) .... PULCHELLA, 30

26. HARPE DIPLOTÆNIA.

Harpe diplotænia Gill, Proc. Ac. Nat. Sci. Phil., 1862, 140; Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 367 (note on *H. diplotænia* Gill) (female).
Cossyphus diplotænia Günther, iv, 110, 1862 (copied).
Bodianus diplotænia Jordan, Proc. U. S. Nat. Mus., 1885, 384 (Cape San Lucas).
Harpe pectoralis Gill, Proc. Ac. Nat. Sci. Phil., 1862, 141; Jordan and Gilbert, Proc. U. S. Nat. Mus., 1882, 367 (note on type) (male).
Cossyphus pectoralis, Günther, iv, 110, 1862 (copied).
Bodianus pectoralis Jordan, Proc. U. S. Nat. Mus., 1885, 384 (Cape San Lucas; Panama).

Habitat.—Pacific coast of Tropical America.

Etymology: Διπλός, double; ταινια, band, from the coloration of the female.

This species was first known from two or three male specimens taken by John Xantus at Cape San Lucas. It has since been taken in abundance by Dr. C. H. Gilbert about the Revilla-Gigedo Islands. As already suspected by us *pectoralis* is the male and *diplotænia* the female of the same species.

27. HARPE RUFA.

LADY-FISH; SPANISH LADY-FISH; SPANISH HOG-FISH; PUDIANO; PERRO COLORADO.

Pudiano vermelho Marcgrave, Hist. Bras., 145, 146, 1648 (Brazil).
Turdus flavus (the Hog-fish) Catesby, Nat. Hist. Carolina, ii, tab. ii, fig. 1; Jordan, Proc. U. S. Nat. Mus., 1884, 194 (identification of Catesby's figure).
Labrus rufus Linnæus, Syst. Nat., Ed. x, 284, 1758, Ed. xii, 475, 1766 (after Catesby); Goode and Bean, Proc. U. S. Nat. Mus., 1885, 200 (note on Linnæan specimen).
Cossyphus rufus Günther, iv, 108, 1862 (Bahia; Jamaica; West Indies); Günther, Shore-Fishes, Challenger 14, 1880 (St. Paul's Rocks).
Harpe rufa Gill, Proc. Acad. Nat. Sci. Phil., 1863, 222; Goode, Fishes Bermudas, 37, 1876 (Bermudas); Jordan and Gilbert, Syn. Fish. N. Am., 601, 1883.
Bodianus rufus Poey, Repertorio, ii, 331, 1867 (Havana); Poey, Synopsis, 331, 1868; Poey, Enumeratio, 105, 1875 (Havana); Jordan, Proc. U. S. Nat. Mus., 1884, 148 (Key West); Jordan, Proc. U. S. Nat. Mus., 1886, 45 (Havana).
Perro colorado Parra, Descr. Dif. Piez. Hist. Nat. Cuba, 3, lam. 3, fig. 1, 1787 (Havana).
Bodianus bodianus Bloch, Ichth., vii, 24, tab. 223, 1790 (from a drawing by Prince Maurice, the same used by Marcgrave).
Cossyphus bodianus Cuv. and Val., xiii, 103, 1839 (San Domingo; Porto Rico; Saint Thomas).
Lutjanus verres Bloch, op. cit., tab. 255, 1791 (locality uncertain).
Cossyphus verres Castelnau, Anim. Nouv. ou Rares, Amerique du Sud., Ichth., 27, 1855 (Bahia; Rio Janeiro).
Sparus falcatus Bloch, op. cit., tab. 258, 1791 (after a drawing by Plumier, made at Martinique).
Bodianus blochii Lacépède, Hist. Nat., Poiss., iv, 279, 290, 1803 (after *Bodianus bodianus* Bloch).

Harpe cœruleo-aureus Lacépède, op. cit., 426, 427, tab. 8, fig. 2 (from the drawing of Plumier, used by Bloch).
Labrus semiruber Lacépède, op. cit., iii, 428 (Rio Janeiro, from notes by Commerson).

Habitat.—West Indian Fauna, north to Key West.

Etymology: *Rufus*, yellowish-red.

This handsomely colored fish is generally common in the West Indies. Our specimens are from Havana.

28. HARPE ECLANCHERI.

Cossyphus eclancheri Valenciennes, Voy. Vénus, Zool., 340, Poiss., pl. 8, fig. 2 (Galapagos Isl.) (plates 1846; text 1855); Günther, iv, 108, 1862.

Habitat.—Galapagos Islands.

Etymology: A personal name.

This species is known from Valenciennes' description and figure only. It much resembles *Harpe rufa*, apparently differing only in color.

29. HARPE TREDECIMSPINOSA.

? *Labrus iagonensis* Bowdich, Excurs. Mad. and Porto Santo, 234, fig. 47, 1825 (Porta Praya); Cuv. and Val., xiii, 100, 1839 (copied) (may be *Lepidaplois scrofa*).
Cossyphus jagonensis Troschel, Wiegmann's Archiv., 229, 1866 (Cape Verde Islands).
Cossyphus tredecimspinosus Günther, iv, 1862, 107 (locality unknown).

Habitat.—Madeira and Cape Verde Islands.

Etymology: *Tredecim*, thirteen; *spinosus*, spined.

This species is known to us only from the scanty description of Dr. Günther. The very imperfect description of *Labrus jagonensis* apparently belongs to some red fish of the *Harpinæ*, but it resembles *Lepidaplois scrofa* about as much as the present species. The presence of thirteen dorsal spines in the original type is probably merely accidental.

30. HARPE PULCHELLA.

Cossyphus pulchellus Poey, Memorias, ii, 208, 1860 (Havana); Günther, iv, 1862 (copied).
Bodianus pulchellus Poey, Syn., 232, 459, 1868; Poey, Enumeratio, 105, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Pulchellus*, pretty.

This species is known to us solely through Poey's descriptions.

Genus IX.—LEPIDAPLOIS.

Lepidaplois Gill, Proc. Ac. Nat. Sci. Phila., 1862, 140 (*axillaris*).
Euhypsocara Gill, op. cit., 1863, 322 (*anthioides*).
? **Gymnopropoma** Gill, op. cit., 1863, 222 (*bilunulata*).

TYPE: *Labrus axillaris* Bennett.

Etymology: *λεπις*, scale; *απλοις*, "a simple cloak that fits the body."

We have not examined any of the typical species of this genus; neither of the two species which we refer to it have been studied by us and

neither of the two have ever been properly described. All the Asiatic species allied to *Harpe* seem to have the soft dorsal and anal low, not at all produced in a point, and this character may therefore be regarded as of generic value. The fins in *Harpe scrofa* seem to agree with those of *H. axillaris*. The form of the dorsal and anal in *H. tredecimspinosus* is not stated, only that the dorsal and anal do not reach the root of the caudal. It may, however, be a true *Harpe*.

ANALYSIS OF EUROPEAN SPECIES OF LEPIDAPLOIS.

a. [Snout pointed, its length $2\frac{2}{3}$ in that of head; preopercle serrate or entire; color bright red, lower parts and fins yellow; dorsal and anal spotted with brown; caudal plain; a large black blotch between the five anterior dorsal spines. D. XII, 10; A. 3, 12–14; scales 6–50–19.] ....SCROFA, 31.

31. LEPIDAPLOIS SCROFA.

Labrus scrofa Cuv. & Val., xiii, 93, 1839 (Cape Verde; Madeira).
Crenilabrus caninus Lowe, Proc. Zool. Soc., 1839, 84; Lowe, Trans. Zool. Soc., ii, 186, and iii, 10 (Madeira).
Cossyphus scrofa Günther, iv, 111, 1862.

Habitat.—Madeira and Cape Verde Islands.

Etymology: *Scrofa*, an old hog, from the large canines.

We know this species from description only. Its scales are smaller than in other species of *Lepidaplois*, but it probably belongs to that genus.

Genus X.—DECODON.

Decodon Günther, Cat. Fish. Brit. Mus., iv, 1862, 101 (*puellaris*)

TYPE: *Cossyphus puellaris* Poey.

Etymology: *Δέκα*, ten; *οδών*, tooth, there being ten canines in the mouth as in most *Harpinæ*.

This genus contains but a single species, a small fish belonging to the West Indian fauna. It is closely related to *Trochocopus* and *Harpe*.

ANALYSIS OF SPECIES OF DECODON.

a. Body moderately compressed, oblong; head oblong; cheeks, opercles, and lower limb of preopercle scaly, the posterior limb being naked; teeth uniserial; four canines in the front of each jaw; maxillary reaching a little beyond eye, which is as wide as the interorbital space, shorter than snout; edge of preopercle minutely denticulated; caudal emarginate; ventrals not reaching vent; color, according to Poey, rose-red with three large red blotches; head with several pearl-colored streaks (yellow in life); a transverse one between the nostrils; two oblique ones running from orbit towards subopercle, and a broad one from angle of mouth to angle of preopercle; some yellow spots on sides of head; each scale on sides with a yellow spot on its edge; fins mostly red, the soft dorsal and anal with four rounded yellow spots; several spots on spinous dorsal and caudal. Head $3\frac{1}{3}$ in length; depth 4; D. XI, 10; A. III, 10; scales $2\frac{1}{2}$–30–8....................PUELLARIS, 32.

32. DECODON PUELLARIS.

Cossyphus puellaris Poey, Memorias Cuba, ii, 210, 1860 (Havana).
Decodon puellaris Günther, iv, 101, 1862 (Barbadoes); Poey, Synopsis, 332, 1868; Poey, Enumeratio, 107, 1875 (Havana); Jordan, Proc. U. S. Nat. Mus., 1884, 545 (Pensacola); Cat. Fish. N. Am., 1885, 98 (Pensacola).

Habitat.—West Indies.

Etymology: *Puellaris*, pretty, from *puella*, girl.

This small species is not uncommon at Havana. The two specimens examined by us were taken from the stomachs of groupers in deep water in the Gulf of Mexico.

Genus XI.—TROCHOCOPUS.

Trochocopus Günther, Cat. Fish. Brit. Mus., iv., 1862, 100 (*opercularis*)
Pimelometopon Gill, Proc. Ac. Nat. Sci. Phil., 1864, 58 (*pulcher*).

TYPE: *Trochocopus opercularis* Günther (East Indies).

Etymology: *Τροχος*, wheel, or a runner; *κόπος*, pain (?) weariness.

This genus is close to *Harpe*, differing chiefly in the naked dorsal and smaller scales. It is divisible into two well-marked subgenera on the size of the scales, *Trochocopus* and *Pimelometopon*.

ANALYSIS OF AMERICAN SPECIES OF TROCHOCOPUS.

a. Scales of moderate size, 45 to 50 in the lateral line. (*Trochocopus*).
b. [Body moderately elongate; highest at the occiput in the adult male; preopercle entire; cheeks and opercles scaly; head compressed; mouth large; canines $\frac{4}{4}$; posterior canine evident; a smaller one before it; a row of smaller teeth in each jaw behind the canines; spinous dorsal very low; second dorsal and anal elevated; longest spine $2\frac{3}{4}$ in longest soft ray, the latter nearly equal to head; pectoral moderate, obliquely truncate; ventrals pointed, inserted behind pectorals; no scaly sheath at base of dorsal. Head 4; depth 4; D. XII, 9; A. III, 12; scales 45 to 50; length m. .63; color uniform black, except a large orange blotch above the pectoral fins.] (*Philippi.*)
MACULATUS, 33.

33. TROCHOCOPUS MACULATUS.

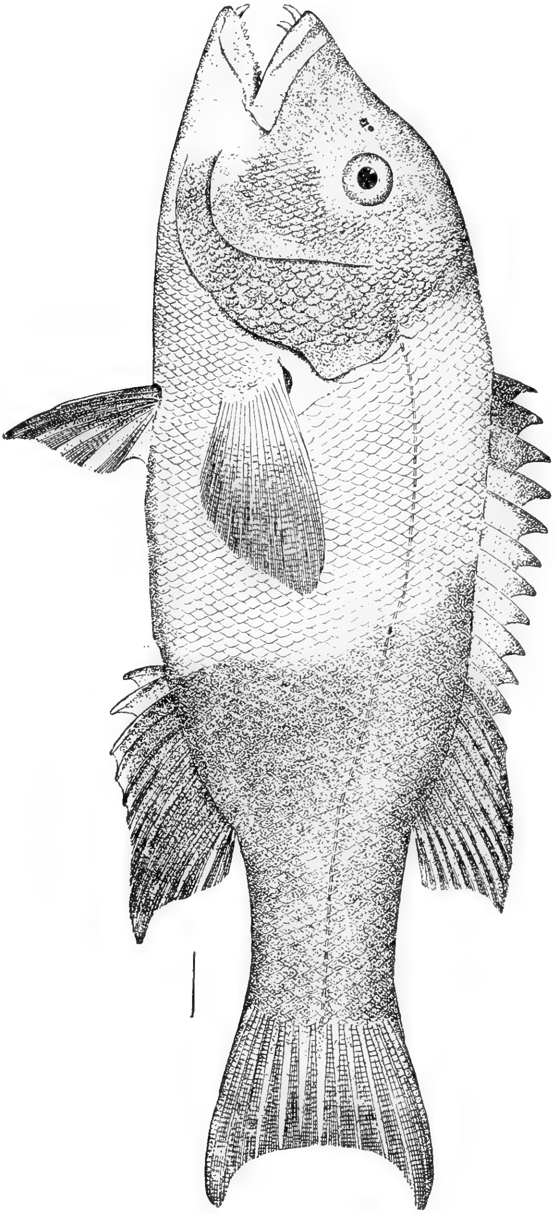
(PEJE-PERRO.)

Dentex maculatus Perez, "Estudio sobre los Escualos de la Costa de Chile," about 1886, p. 11 (Valparaiso).
Trochocopus canis Philippi, Sobre los Tiburones, etc., de Chile, 1887, 38, lam. vii, fig. 3 (Iquique).

Habitat.—Coast of Chili.

Etymology: Latin *maculatus*, spotted.

We know this species from the account given by Dr. Philippi. The fact that Dr. Perez curiously mistook this fish for a Sparoid does not justify Dr. Philippi in setting aside the specific name proposed by the latter.



TROCHOCOPUS PULCHER Ayres. California Redfish; Fathead.
(No. 24890, U. S. N. M.; from San Diego, California.)

aa. Scales small, about 60 in the lateral line. (*Pimelometopon, Gill.*)

c. Body somewhat deep and compressed, the head 3 in length; depth 3; eye 5 in head; snout rather blunt; caudal truncate, its lobes being produced and pointed in the adult; gill-rakers short and thickish; scales on breast small; preopercle serrulate in young. Color (males): head, dorsal, anal, and caudal fins, also the posterior part of body as far forward as vent, purplish black; lower jaw white; the rest of body varying in tint from clear crimson to blackish, with coppery or purplish luster; females dusky rose-colored, with the black areas ill-defined or obsolete. D. XII, 10; A. III, 12; lat. l. 60 .... PULCHER, 34.

cc. [Snout pointed; outer lobes of caudal noticeably produced as are also the soft dorsal and anal; preopercle entire. Color, red; a large, yellow blotch above the pectoral, and a black one anteriorly on the spinous dorsal.] D. XII, 10; A. III, 12; lat. l. 62. (*Valenciennes*) .... DARWINII, 35.

34. TROCHOCOPUS PULCHER. (PLATE IV.)

(CALIFORNIA REDFISH; FATHEAD.)

Labrus pulcher Ayres, Proc. Cal. Acad. Nat. Sci., i, 3, 1854 (San Diego).
Semicossyphus pulcher Günther, iv, 99, 1862 (copied).
Pimelometopon pulcher Gill, Proc. Acad. Nat. Sci. Phila., 1864, 59; Jordan, Proc. U. S. Nat. Mus., 1880, 29 (San Diego); Jordan & Gilbert, l. c., 455; Jordan and Jouy, l. c., 1881, 10 (Wilmington, Santa Barbara, Cal.).
Harpe pulcher Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 278 (Ascension Island, Lower California); Jordan & Gilbert, Syn. Fish. N. Am., 1883, 602.
Trochocopus pulcher Rosa Smith, Proc. U. S. Nat. Mus., 1883, 233 (Todos Santos); Jordan, Cat. Fish. N. Am., 98, 1885; Jordan, Nat. Hist. Aquat. Anim., 275, 1885 (Point Conception to Cerros Island).

Habitat.—Coast of southern California, from Point Conception to Cerros Island.

Etymology: *Pulcher*, beautiful.

This large and handsome fish is very common on the coast of southern California, and it is taken in enormous numbers in the kelp of the coast. It is taken chiefly by the Chinese, with hook and line. It is salted and dried by them. It reaches a weight of 12 to 15 pounds. The male is quite different in color from the female, and the old specimens, as usual with large Labroids, have the forehead surmounted by a mass of fat.

The specimens before us are from San Diego.

35. TROCHOCOPUS DARWINII.

Cossyphus darwinii Jenyns, Voy. Beagle, Fishes, 100, pl. 20, 1842 (Chatham Island, Galapagos).
Trochocopus darwinii Günther, iv, 100, 1862 (copied).
Pimelometopon darwinii Gill, Proc. Acad. Nat. Sci. Phila., 1864, 59.
Labrus aper Valenciennes, Voy. de la Vénus, Zool., 338; Poiss., pl. 8, f. 1 (Galapagos Island) (text, 1855; plates, 1846).

Habitat.—Galapagos Islands.

Etymology: Named for its discoverer, Charles Darwin.

This species is known to us from descriptions only. It is evidently very closely related to *T. pulcher*, differing from the latter chiefly in color.

Genus XII.—GRAUS.

Graus Philippi, Sobre los Tiburones y algunos Otros Peces de Chile, 1887, 41 (*nigra*).

TYPE: *Graus nigra* Philippi.

Etymology: *Γράος*, an old woman; the word corresponding to the Spanish *vieja*.

This genus is based on a single species, found on the coast of Chili. It is evidently very close to *Trochocopus*.

ANALYSIS OF SPECIES OF GRAUS.

a. [Body moderately elongate; anterior profile regularly curved; head compressed, formed as in *Trochocopus maculatus;* preopercle entire; soft dorsal and anal similar, the soft rays just twice the height of the longest spines, $2\frac{1}{3}$ in head; scales moderate, smaller than in *Trochocopus maculatus;* forehead scaly (?); opercles with small scales; no scales on sheath at base of dorsal; canines large, $\frac{4}{6}$ on each side; no posterior canine; a second row of small teeth behind the main row in each jaw; (gills 4); pectorals rounded; ventrals pointed, inserted behind pectorals; color dusky, each scale with a black spot at its base so that the fish appears reticulate; D. XIII; length m. .58; depth m. .12; head m. .135.] (*Philippi.*)
NIGRA, 36.

36. GRAUS NIGRA.

(VIEJA NEGRA.)

Graus nigra Philippi, Sobre los Tiburones, etc., 1887, 40 (Navidad, Chili).

Habitat.—Coast of Chili.

Etymology: Latin *niger*, black.

This species is known only from the scanty description of Dr. Philippi, condensed above.

Genus XIII.—CLEPTICUS.

Clepticus Cuv. & Val., Règne Animal, Ed. ii, 1829, 201 (*genizara*).

TYPE: *Clepticus genizara* Cuvier.

Etymology: *Κλεπτικος*, one inclined to steal; a name given to recall the affinity of the genus to *Epibulus*, from *επιβουλος*, insidious, its Dutch name in Molucca being *de Bedriger*.

This genus contains a single species, a singular-looking Labroid fish, inhabiting the West Indian waters. It is remarkable for the close squamation of its head and fins, as well as for the feebleness of its dentition.

ANALYSIS OF SPECIES OF CLEPTICUS.

a. Body robust, considerably compressed, depth $2\frac{2}{5}$ in length, head $3\frac{3}{5}$; four rows of scales on cheek; pectorals falcate, slightly longer than head; dorsal and anal completely enveloped in a scaly sheath; produced soft rays of both fins naked except at base; produced ray of dorsal nearly as long as head; color in spirits reddish-brown anteriorly as far back as an irregular line connecting ventrals and last ray of dorsal fin, becoming coppery below, posteriorly insensibly shading into greenish marbled with verdigris green; D. XII, 90; A. III, 12; scales 5–35–9.
GENIZARA, 37.

37. CLEPTICUS GENIZARA.

(GENIZARA.)

Rabirrubia genizara Parra, Dif. Piezas de Hist. Nat. Cuba, 44, pl. 21, f. 1, 1787 (Havana).

Clepticus genizara Cuvier, Règne Animal, Ed. ii, 1829, 201 (after Parra); Cuv. & Val., xiii, 367, pl. 377, 1839 (Antilles); Günther, iv, 112, 1862 (Jamaica); Poey, Repert., i, 370, 1866; Poey, Synopsis, 332, 1868; Poey, Enumeratio, 107, 1875 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 45 (Havana).

Habitat.—West Indies.

Etymology: Spanish *genizara*, janissary; from its gay coloration.

This species seems to be rather rare in the West Indies. We have a single specimen nearly a foot long, from Havana.

Genus XIV.—PSEUDOLABRUS.

Pseudolabrus Bleeker, Proc. Zool. Soc. London, 1861, 413 (*rubiginosus*)

? **Labrichthys** Bleeker, l. c., 415 (*cyanotænia*).

TYPE: *Labrus rubiginosus* Schlegel.

Etymology: *Ψευδής*, false; *Labrus*, an allied genus.

A single species of this East Indian genus occurs on the Pacific coast of South America. Dr. Günther unites *Labrichthys* with *Pseudolabrus*, not regarding either the single (instead of double) row of teeth on the lower pharyngeal or the slight sheath of scales at the base of the dorsal in the former group as of generic value. In any case, the name *Pseudolabrus* has priority, and it is to that group that our species apparently belongs.

ANALYSIS OF AMERICAN SPECIES OF PSEUDOLABRUS.

a. [A small posterior canine; four rows of small scales on cheeks below the eye; a small blue spot on the upper part of the base of pectoral; edges of the scales paler than the middle; pectorals bright yellow; dorsal generally dull indigo blue. D. IX., 11; A. III, 10; scales 3-25-8.] (*Steindachner.*) .... GAYI, 38.

38. PSEUDOLABRUS GAYI.

Labrus gayi Cuv. & Val., xiii, 97, 1839 (Juan Fernandez); Guichenot, in Gay, "Hist. Chil., Zool., ii, 299, lam. 8, f. 1."

Labrichthys gayi Günther, iv, 115, 1862 (copied); Steindachner, Ichth. Beitr., ii, 19, 1875 (Juan Fernandez; Chili).

Habitat.—Coast of Juan Fernandez and Chili.

Etymology: Named for Claude Gay, author of a history of Chili.

We know this species from the scanty published descriptions.

Genus XV.—JULIS.

? **Coris** Lacépède, Hist. Nat. Poiss., iii, 96, 1802 (*aygula*).

Julis Cuvier, Règne Animal, Ed. i, 1817, 262 (*julis*, etc.).

Julis Swainson, Nat. Hist. Classn. Fishes, ii, 1839, 233 (restricted to *julis=Julis mediterranea* Swainson.)

Julis Bonaparte, Catologo Metodico, 1846, 86 (*julis.*)

Coris Günther, iv, 195, 1862 (in part: probably not type.)

TYPE: *Labrus julis* Linnæus.

Etymology: Ἰουλις, name of some red Labroid, from ἴον, violet.

This genus, as now restricted, contains some half dozen species of the eastern Atlantic and the East Indies. We have not been able to study critically many of the foreign species referred to *Coris*. It seems to us that the type of the latter genus, *Coris aygula*, with 60 scales in the lateral line and weak or wanting posterior canines should not be congeneric with *Julis julis*, but is related rather to the group called *Hermicoris* by Bleeker. *Pseudocoris* Bleeker and *Hologymnosus* Lacépède, referred by Günther to *Coris*, seem to be distinct genera.

The name *Julis*, used for the group here called *Thalassoma* by Günther and Bleeker, was originally based by Cuvier on *Labrus julis*, and it was further explicitly restricted to this species by Swainson, who declared that *Julis mediterraneus* Risso (*Labrus julis* L.) is the *Julis* of the ancients.

ANALYSIS OF EUROPEAN SPECIES OF JULIS.

a. Male with the anterior spines of the dorsal elevated, flexible, nearly half length of head; females with the spines subequal, slender, but more or less pungent; body elongate, somewhat compressed, covered with small scales, the head naked; canine teeth $\frac{4}{4}$, the outer pair smaller; caudal fin subtruncate; male brown above, a broad red band (whitish in spirits) with serrated edges from the eye across opercle to upper part of base of caudal; below this a brown band, its upper edge jagged, its lower fading into the color of the belly; this band on the head is bounded below by a dark line, but fades into the pale band above; an oblong jet-black blotch about as long as head immediately behind pectoral, its upper edge along lower edge of red band; a jet-black spot on tip of opercle; front of spinous dorsal black, the long spines tipped with white; dorsal whitish, with one or two grayish longitudinal streaks; anal pale; caudal pale, sometimes with very faint oblique streaks; sometimes the pale lateral band wanting and the body marked with dark cross-streaks (var. *speciosa*); female pale, with a dusky lateral shade from snout through eye to base of caudal; sometimes a narrow streak below this; jet-black spot on opercle present; fins pale, unmarked; young males sometimes with the upper half of the body dark, the lower from the level of the eye abruptly pale; the opercular spot present in both sexes at all ages. Head $3\frac{1}{2}$ in length; depth $4\frac{1}{2}$; D. IX, 12; A. III, 12; scales 3–75–25; vertebræ $11 + 14 = 25$ .... JULIS, 39.

39. JULIS JULIS.

(RAINBOW WRASSE; DONCELLA.)

Labrus palmarius varius Artedi, Genera 34, Syn. 53, 1738.

Labrus niloticus Hasselquist, "Iter Palæstinum, 1757, 346," (Egypt). (Pre-Linnæan.)

Labrus julis Linnæus, Syst. Nat., ed. x, 1758, 284 (after Artedi) (and of copyists).

Coris julis Günther, iv, 195; Steindachner, Ichth. Bericht. 1868, 35; Day, British Fishes, 269 (and of many recent writers).

Labrus niloticus Linnæus, Syst. Nat., ed. x, 1758, 286 (after Hasselquist).

Labrus perdica Forskål, Descr. Anim., 34, 1775 (Constantinople).

Labrus subfuscus Bloch & Schneider, Syst. Ichth., 1801, 28 (after Gronow; Mediterranean).

Labrus giofredi Risso, Ichth. Nice, 1810, 228 (female).

Julis giofredi et vars. *argentata* et *fuscoviolacea* Risso, Eur. Mérid., 1826.

Julis giofredi Cuv. & Val., xiii, 371, pl. 385.
Coris giofredi Günther, iv, 196.
? *Labrus doncella* Rafinesque, Caratteri, 1810, 39.
Labrus cettii Rafinesque, Indice, 1810, 54.
Julis mediterranea Risso, Eur. Mérid., iii, 309, 1826; and of some authors.
Julis mediterranea vars. *viridula* et *pallidula* Risso, l. c.
Julis speciosa, Risso, l. c. 311.
Julis speciosa var. *unicolor*, Risso, l. c.
Julis vulgaris Fleming, British Animals, 1828, 210; Cuv. & Val., xiii, 361.
Julis festiva Cuv. & Val., xiii, 374, 1839.
Julis melanura, Lowe, Trans. Zool. Soc. London, iii, 12 (Madeira).

Habitat.—Shores of southern Europe, north to England.

Etymology: *Ιουλις*, ancient name of some small violet-colored fish, from *ἴον*, violet.

This beautiful little fish is generally common in the waters of southern Europe and the Madeira Islands. The females were for a considerable time thought to represent a distinct species *Coris* (or *Julis*) *giofredi*. Besides this sexual variation, there is much individual variation in the color of specimens. Our specimens are from Palermo and from the shores of France.

Genus XVI.—LEPTOJULIS.

Leptojulis Bleeker, Proc. Zool. Soc. London, 1861, 412, *cyanopleura*.

TYPE: *Leptojulis cyanopleura* Bleeker.

Etymology: *Λεπτός*, slender; *Julis*, an allied genus.

This genus consists, so far as known, of three species of brightly colored Labroids, two of them found in the East Indies, the other on the west coast of South America.

ANALYSIS OF AMERICAN SPECIES OF LEPTOJULIS.

a. [Four rows of scales between the lateral line and first dorsal spine; two anterior canines in upper jaw much longer than the outer ones; outer canines of lower jaw little longer than the inner ones, which are somewhat shorter than the opposite ones of the upper jaw; caudal rounded, the outer rays somewhat prolonged; general color brownish yellow; a large (in some specimens small) blotch under the fifth scale of the lateral line, this blotch being surrounded by a blue shade or by blue dots; a second blotch on and partly over the last scale of the lateral line; several blue radiating lines about the eye; on the cheeks and opercle brownish wave-like lines, with single golden red spots and dashes upon the back of head and the upper part of the opercle; dorsal plain golden white, colored like the anal; the latter with the longitudinal faint narrow brown stripe; caudal yellowish green, a bright red stripe running over the center of each row of scales.] D. IX, 11; A. III, 11; scales 4–27–9. (*Kner* and *Steindachner*) ....BIMACULATUS, 40.

40. LEPTOJULIS BIMACULATUS.

Leptojulis bimaculatus Kner and Steindachner, Neue Fische aus dem Museum Godeffroy, Hamburg, 23, 1866 (Chili).

Habitat.—Coast of Chili.

Etymology: *Bimaculatus*, two-spotted.

This species is known from the original description only.

Genus XVII.—HALICHŒRES.

Halichœres Rüppell, Neue Wirbelthiere, Fische, 16, 1835 (*bimaculatus*, etc.) (not preoccupied by *Halichœrus*, a genus of seals).

Platyglossus species Günther, and most recent authors; probably not identical with *Platyglossus* Bleeker, Proc. Zool. Soc. London, 1866, 411 (*marginatus*).

Ichthycallus Swainson, Nat. Hist. Class'n Anim., ii., 1839, 232 (*dimidiatus*, etc., a confused jumble of species).

Chœrojulis Gill, Proc. Ac. Nat. Sci. Phila., 1862, 142 (substitute for *Halichœres*).

TYPE: *Halichœres bimaculatus* Rüppell.

Etymology: Ἅλς, the sea; χοίρος, hog.

I adopt the genus *Halichœres* as defined by Bleeker, and in a sense somewhat narrower than that in which it is taken by Dr. Günther. I separate from it *Platyglossus* (*marginatus*). The dorsal in *Platyglossus* has a scaly sheath at its base somewhat as in the genus *Harpe*. The anterior canines in *Platyglossus* are $\frac{2}{2}$. In *Güntheria* (*cœruleovittata*) the upper part of the opercle is scaled and the canines are $\frac{4}{2}$. In *Hemitautoga* (*centiquadra*) there are two rows of small scales on the cheeks, as well as on the opercles above. In *Macropharyngodon* (*gœffroyi*) the strongest marked of the various genera of Bleeker, which Günther has united with *Platyglossus* and *Halichœres*, the lower pharyngeals are very small, provided with but three teeth, of which the middle one is quite large. In *Macropharyngodon*, the canines are small, $\frac{4}{2}$ in number. All the American species now referred to *Halichœres* have the anterior canines $\frac{2}{4}$. The East Indian species have the teeth $\frac{2}{2}$, except in two or three species, in which the teeth are $\frac{4}{2}$. The American species may properly be held to constitute a subgenus, or perhaps even a distinct genus, for which the name *Ichthycallus*, based in part on *Halichœres dimidiatus*, may be retained.

Most or all of the species of *Ichthycallus* have three anal spines, while in *Halichœres* the usual number is two.

Should the name *Halichœres* be regarded as preoccupied by the similar name *Halichœrus*, this genus may be called *Ichthycallus* or *Chœrojulis*.

ANALYSIS OF AMERICAN SPECIES OF HALICHŒRES.

I. Anterior canines $\frac{2}{4}$; anal spines three; American species (Subgenus *Ichthycallus* Swainson).

a. Caudal fin very slightly concave, truncate when spread open, the outer rays longer than the middle ones; body deep and compressed; the depth about $2\frac{3}{4}$ in the length; ventral fins filamentous, the outer ray produced, more than twice as long as inner ray; scales before dorsal not crossing the middle line, in about five series.

b. Side below spinous dorsal without dark cross-bar; general color bluish (♂) or bronze (♀) with many sky-blue spots, most distinct posteriorly; sky-blue spots and streaks on head; a stripe passing through upper part of eye; fins with blue stripes; a dark axillary spot; end of pectoral dusky .... RADIATUS, 41.

bb. Side below spinous dorsal with a very broad, blackish cross-bar.

c. General color bluish or olive; dark cross-bar obscure, running from middle of spinous dorsal to the space between ventrals and vent; behind this a pale yellowish bar; head and anterior region with round pale bluish spots, which extend on back and on the dark bar; dorsal bluish at base, yellowish above, with regular blue spots ringed with darker; a narrow blue margin along edge of fin; caudal with obscure round bluish spots; anal like dorsal; pectorals and ventrals plain.................NICHOLSI, 42.

cc. General color red; dark cross-bar conspicuous from the fourth to seventh dorsal spines downwards to middle of sides; scales of sides each with a vertical blue line, those anteriorly margined with violet; sides of head with blue lines and spots; dorsal and caudal orange, the former with oblique broken lines of blue, the latter with a few blue spots at base; anal violet, then yellowish, then margined with blue, with a blue median line and broken blue lines at base; other fins pale. Head $3\frac{1}{4}$ in length; canines strong, scales on nape in 5 or 6 series, not crossing the median line; caudal very slightly emarginate; outer ray of ventrals twice inner ray and reaching vent.....SELLIFER, 43.

aa. Caudal fin rounded or subtruncate; the outer rays not produced, shorter than the middle rays.

d. Scales before dorsal reduced in size, extending across the median line, and in 10 to 13 rows; ventral short, its rays not filamentous; snout rather blunt; body moderately elongate, the depth $3\frac{2}{3}$ in length; color olivaceous, with some blue and bronze markings; males with a broad indigo-blue cross-band behind pectorals; females with inky spots on the scales of the upper posterior part of back; pectorals yellow, with a black axillary spot. SEMICINCTUS, 44.

dd. Scales before dorsal large, in 4 to 6 rows, not crossing the median line; snout moderately pointed.

e. Ventral fins with the outer rays produced, more than twice the length of the inner.

f. Sides without conspicuous dark lateral band and with a distinct dark vertical bar, extending downward from spinous dorsal; axillary spot obscure; body rather elongate, the depth about $3\frac{2}{3}$ in length; profile not steep; posterior canines rather small; head with black streaks and spots above; caudal sharply barred..GARNOTI, 45.

ff. Side with a broad blue-black lateral band extending from eye to tip of caudal; the back above this dark brown or bluish; spinous dorsal fin with no conspicuous black spot; a dark blue stripe from eye to nape; fins mostly blue-black with pale edgings; middle and base of caudal dusky; tip of pectoral dusky; profile rather steep; body rather robust, the depth $3\frac{1}{3}$ in length...DIMIDIATUS, 46.

ee. Ventral fins with the outer ray not produced, its length not more than half that of inner rays; side with a dark lateral band; species of small size.

g. Spinous dorsal with a conspicuous blue-black spot between the fifth and seventh spines; body not very slender, the depth $3\frac{2}{3}$ in length; a dark band from snout through eye to opercle, the lateral band on side broader than eye and placed a little above the opercular band, the lateral band extending nearly to tip of caudal; no second dark band below it; a faint dark spot

under last dorsal ray and one at base of pectoral above; two or three narrow bluish-white stripes across cheek; "three bluish bands across nape" (not shown in our specimen); body and fins in life with bright colors which fade in alcohol.

MACULIPINNA, 47.

gg. Spinous dorsal pale, the black spot very small or wanting; body slender, the depth 4 in length; opercle with a conspicuous black spot; a blue-black band from snout through eye and across opercles to base of caudal, not extending on the fin; a narrower and fainter band from lower base of pectoral to above anal, these bands growing fainter with age and sometimes disappearing, the lower always wanting in the adult; no axillary spot; no distinct bands across cheek; fins mostly pale, with bright red and blue colors in life, young specimens and deep water specimens often showing a black spot at base of caudal, and sometimes a dark spot near middle of dorsal with sometimes a larger one at the base of its last ray; angles of caudal black in adult; lower pharyngeals T-shaped, the anterior limb very short.......................................BIVITTATUS, 48.

aaa. Caudal fin double-concave, the median portion convex, the outer rays more or less produced in the adult (the fin rounded in the young); scales before dorsal in six or seven rows, not crossing the median line.

h. A round blue-black spot on lateral line below fourth and fifth dorsal spines, the spot larger than eye; no spot behind eye; ventrals with the outer ray little produced, not reaching nearly to tips of pectorals; body rather stout, the depth about $3\frac{3}{5}$ in length; profile steep; snout moderately pointed; no axillary spot; color olive, blue spots on the scales posteriorly, whitish spots anteriorly; four or five pale blue wavy lines on side of head, the lower broadest; a pale yellowish area behind pectoral with horizontal blue streaks; dorsal and anal each with a brown longitudinal stripe; caudal (in ♂) blackish mesially, with blue streaks; a white stripe along each outer ray.

DISPILUS, 49.

hh. A distinct blue-black spot close behind eye; ventrals with the outer rays scarcely filamentous, about reaching tips of pectorals.

i. Tubes of pores of lateral line distinctly branched, the branches usually three in number; body moderately slender, the depth a little less than length of head, and $3\frac{3}{4}$ to 4 in body; head $3\frac{2}{5}$; snout not very sharp, the anterior profile of head steep and slightly convex; snout $2\frac{1}{5}$ in head measured along the axis; eye $1\frac{2}{5}$ in snout; pectoral shortish, $1\frac{3}{5}$ in head; color in spirits, olivaceous, with traces of three darker cross-bands; dark spot behind eye large, with a distinct golden spot above it in some examples; a round black spot at base of last ray of dorsal; fins all pale in spirits, the anal edged with bluish; a bluish cross bar on base of pectoral ....POEYI, 50.

ii. Tubes of pores of lateral line all simple or very nearly so, not trifid; body very slender, the depth much less than length of head, $4\frac{1}{2}$ in body; head $3\frac{2}{5}$; snout very sharp, the anterior profile of head straightish and not steep; snout $2\frac{1}{5}$ in head; eye 2 in snout; pectoral moderate, $1\frac{3}{5}$ in head; color, in spirits, pale, unmarked, except for the small black spot behind eye; in life, olivaceous; a row of round sky-blue spots along each

side of back; a broad band-like area of orange mingled with violet spots along sides backward from head to middle of body, the lower edge of this band serrate; below this a pale violet band darker behind; still lower a yellow stripe; head olivaceous, marked with blue; preorbital scarlet, with three violet stripes; opercles bright red, with three violet stripes, the postocular black spot in the uppermost; dorsal and anal orange and yellow, with blue spots; caudal with convergent bands of orange forming reticulations around blue spots..CAUDALIS, 51.

41. HALICHŒRES RADIATUS.

(PUDDING-WIFE; DONCELLA; PUDIANO VERDE.)

Pudiano verde Marcgrave, Hist. Pisc. Brazil, 146, 1648 (Brazil; on a drawing by Prince Maurice of Nassau).

Turdus oculo radiato (Pudding-wife) Catesby, Nat. Hist. Carol., ii, 12, tab. xii, fig. 1, 1743 (Bahamas).

Labrus radiatus Linnæus, Syst. Nat., Ed. x, 288, 1758 (based on Catesby).

Platyglossus radiatus Günther, Cat. Fish. Brit. Mus., iv, 163, 1862 (copied); Jordan, Proc. U. S. Nat. Mus., 135, 1884 (Key West); Jordan, Proc. U. S. Nat. Mus., 194, 1884 (identification of Catesby's figure); Jordan, Bull. U. S. Fish Com., 78, 1884 (Key West); Jordan, Cat. Fish. N. Am., 98, 1885; Jordan, Proc. U. S. Nat. Mus., 45, 1886 (Havana).

Chœrojulis radiatus Goode, Bull. U. S. Nat. Mus., v, 35, 1875 (Bermudas).

Doncella Parra, Desc. Dif. Piez. Hist. Nat. Cuba, 95, lam. 37, fig. 1, 1787 (Havana).

Labrus brasiliensis Bloch, Ichth., taf. 280, 1792 (Brazil; on a drawing by Prince Maurice of Nassau, of the *Pudiano verde*); Bloch & Schneider, Systema Ichthyol., 242, 1801 (copied).

Chlorichthys brasiliensis Swainson, Class. Fish., etc., 232, 1839 (name only).

Julis crotaphus Cuvier, Règne Anim., Ed. ii, 1828 (based on Doncella of Parra; no description).

Julis cyanostigma Cuv. & Val., Hist. Nat. Poiss., xiii, 391, 1839 (Martinique).

Platyglossus cyanostigma Günther, Cat. Fish. Brit. Mus., iv, 161, 1862 (Caribbean Sea); Cope, Trans. Am. Phil. Soc., 464, 1871 (St. Croix); Günther, Shore Fishes, Challenger, 4, 1880 (St. Paul's Rocks, mid-Atlantic).

Chœrojulis cyanostigma Poey, Synopsis Pisc. Cub., 334, 1868 (Havana); Poey, Enumeratio, 1875, 107 (Havana).

Julis opalina Cuv. & Val., Hist. Nat. Poiss., xiii, 392, 1839 (Martinique).

Platyglossus opalinus Günther, iv, 163, 1862 (copied).

Julis patatus Cuv. & Val., xiii, 398. 1839 (Martinique; Cuba).

Julis principis Cuv. & Val., xiii, 402, 1839 (Bahia).

Platyglossus principis Günther, iv, 164, 1862 (copied).

Platyglossus radiatus Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 59 (Key West; Havana).

Habitat.—West Indian fauna; Florida Keys to Brazil.

Etymology: *Radiatus*, radiant.

This is the largest in size of the American species of this genus, and one of those most readily recognized. It has been well described by Professor Goode, who has noted the variations due to age, and by Professor Jordan (Proc. U. S. Nat. Mus., 1884, 194), who has indicated the several variations in the adult.

This species is evidently the *Pudiano verde* of Marcgrave, the Pudding-wife of Catesby, and the *Doncella* of Parra.

The *Labrus radiatus* of Linnæus, in the tenth edition, is based solely on the pudding-wife* of Catesby. The Linnæan name, *radiatus*, must therefore be taken for this species. In the twelfth edition the *Labrus radiatus* disappears, and the pudding-wife appears as a doubtful synonym of a *Sparus radiatus*, which is based on a specimen of *H. bivittatus* sent by Dr. Garden from South Carolina.

The *Labrus brasiliensis* of Bloch is a fairly good figure of the female of this species, except that the coloration is made bright yellow and orange, rather than olive and bronze.

The *Julis crotaphus* of Cuvier is based solely on a reference to Parra's Doncella, and must therefore be referred to this species, although the fish subsequently described as *Julis crotaphus* by Valenciennes seems to be *H. Poeyi.* The names *cyanostigma*, *patatus*, and *principis* are regarded by Goode as referring to different stages in the growth of this species. This view seems to be correct, and we may add *opalina* also as apparently the adult female.

The specimens of this species examined by us are all adult (15 to 18 inches long) and are from Key West and Havana.

42. HALICHŒRES NICHOLSI.

Platyglossus nicholsi Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 231 (Braithwaite Bay, Socorro island); Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 61.

Habitat.—Islands of the west coast of tropical America, Revilla-Gigedos and Galapagos.

Etymology: Named for Capt. Henry E. Nichols, U. S. Navy.

This species was first described from a single specimen from Socorro Island. A second and larger example, 13½ inches long, taken by the Albatross at Charles Island in the Galapagos, shows the original coloration better than the type. This species is the Pacific representative of *Halichœres radiatus.* Other specimens have been since obtained at the Revilla-Gigedos by Dr. Gilbert.

43. HALICHŒRES SELLIFER.

Halichœres sellifer Gilbert, Proc. U. S. Nat. Mus., 1890 (Clarion Island).

Habitat.—Revilla-Gigedos Islands.

Etymology: *Sella*, saddle; *fero*, I bear.

This handsome species is known from a single specimen 11 inches long, taken by Dr. Gilbert at Clarion Island

It is closely related to *H. nicholsi*, differing chiefly in its red color, a hue which is rare in the present genus.

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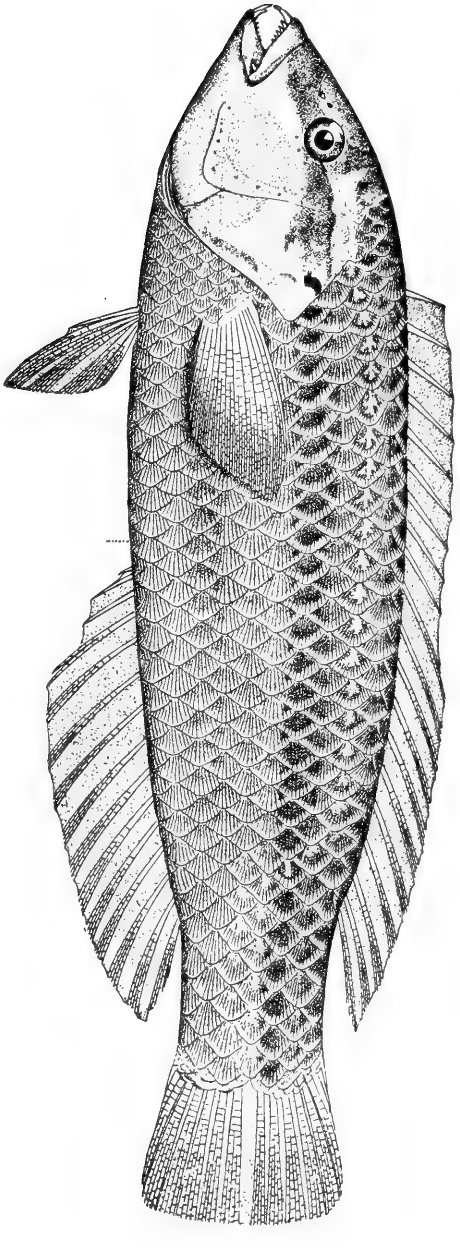
* This name "pudding-wife" still used by the fishermen of the Florida Keys and the Bahamas, seems to be a remarkable compound of the Portuguese "Pudiano" (from *pudor*, modesty) the name of the brighter colored Labroids in Brazil, and "old-wife" or "Vieja," a name given to some of the Scaroid fishes in the West Indies and as "old-wife" to the larger Labroids in England.



HALICHŒRES BIVITTATUS Bloch. Slippery Dick; Doncella. (Young.)

(No. 35168, U. S. N. M.; from Key West, Florida.)

44. HALICHŒRES SEMICINCTUS.

(KELP-FISH; SEÑORITA.)

Julis semicinctus Ayres, Proc. Cal. Acad., 32, 1859 (Cerros Island; male).

Platyglossus semicinctus Günther, Cat. Fish. Brit. Mus., iv, 161, 1862 (copied); Steindachner, Ichthy. Beiträge, v, 151, 1876 (San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 455, 1880 (San Pedro); Jordan & Gilbert, Proc. U. S. Nat. Mus., 10, 1881 (Wilmington, Cal.); Jordan & Gilbert, Proc. U. S. Nat. Mus., 52, 1881 (Santa Catalina, San Pedro); Jordan & Gilbert, Synopsis Fish. N. Am., 603, 1883; Jordan, Cat. Fish. N. Am., 99, 1885; Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 60 (San Diego).

Chœrojulis semicinctus Gill, Proc. Ac. Nat. Sci. Phil., 223, 1863 (no description).

Habitat.—Lower California fauna; Los Angeles to Cerros Island.

Etymology: *Semicinctus*, half-banded.

This species reaches a length of about a foot. It has been described with sufficient accuracy by Steindachner and by Jordan & Gilbert (Synopsis). The coloration is comparatively plain, but that of the female is notably different from that of the male.

The specimen before us is from San Diego.

45. HALICHŒRES GARNOTI.

Julis garnoti Cuv. & Val., xiii, 390, 1839 (Martinique); Guichenot in Sagra, Hist. de Cuba, 218, about 1855 (Havana).

Platyglossus garnoti Günther, iv, 162, 1862 (Martinique); Jordan, Proc. U. S. Nat. Mus., 45, 1886 (Havana); Jordan & Hughes, l. c., 1886, 61 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 541 (Martinique; types of *Julis garnoti*).

Julis cinctus Poey, Mem. Cuba, ii, 211, tab. 13, fig. 19, 1860 (Havana).

Chœrojulis cinctus Poey, Synopsis, 334, 1868 (Havana); Poey, Enumeratio, 108, 1875 (Havana).

Julis ruptus Poey, Mem. Cuba, ii, 212, tab. 13, fig. 20, 1860.

Chœrojulis ruptus Poey, Synopsis, 334, 1868 (Havana).

Platyglossus ruptus Cope, Trans. Am. Phil., Soc., 464, 1870 (St. Croix).

Habitat.—West Indian fauna.

Etymology: Named for M. Garnot, a collector at Martinique.

Of this small species we have but two specimens, each about 8 inches long, from Havana. Poey notes that this species varies much in color-markings, and includes in his Enumeratio his *Julis ruptus* as a synonym of *Julis cinctus*. The types of *Julis garnoti* examined by us in Paris belong to the same species.

The life coloration in our specimens of *H. garnoti* was as follows:

Head olive, shaded with brown; bright violet-blue on the lower jaw; dark violet dots and streaks behind and above eye; shoulders deep yellow-olive; behind this a blackish cross-band, behind which the back and the base of the dorsal is a rich maroon-crimson; body below this livid purplish, shaded with olive. Spinous dorsal olive, with blue dots; soft dorsal bluish, banded with bronze and edged with dusky; caudal bluish-gray, with sharply-defined, narrow, bronze bands; anal olive-reddish, with streaks of crimson, violet, and blue; pectorals light reddish, their tips black; axil violet; ventrals pale; a diffuse dusky spot at upper base of caudal.

46. HALICHŒRES DIMIDIATUS.

? *Labrus cyanocephalus* Bloch, Ichthyol., pl. 286, 1791 (Museum of Link).

Julis dimidiatus Agassiz, in Spix, Pisc. Braz., 96, pl. 53, 1829 (Brazil); Cuv. & Val., xiii, 407, 1839 (Martinique; Brazil).

Ichthycallus dimidiatus Swainson, Class. Fish, etc., 232, 1839 (name only).

Platyglossus dimidiatus Jordan, Proc. U. S. Nat. Mus., 45, 1886 (Havana); Jordan & Hughes, l. c., 1886, 61 (Havana).

Julis internasalis Poey, Mem. Cuba, ii, 421, 1860 (Havana).

Platyglossus internasalis Günther, Cat. Fish. Brit. Mus., iv, 164, 1862 (Caribbean Sea); Cope, Trans. Am. Phil. Soc., 463, 1870 (St. Martin's).

Chœrojulis internasalis Poey, Synopsis, 334, 1868 (Havana); Poey, Enumeratio, 108, 1875 (Havana).

Habitat.—West Indian fauna; south to Brazil.

Etymology: *Dimidiatus*, halved, the upper half of the body being colored differently from the lower.

There seems to be no reason for regarding the Cuban *internasalis* as different from the Brazilian *dimidiatus*, the alleged differences in color being due to defects in descriptions. A specimen before us from Bahia shows the band from eye to nape very distinctly. It is broader behind and edged with darker blue. We have also examined a smaller specimen from St. Lucia. Two male specimens of *H. dimidiatus* from Havana are each about 15 inches in length. In life they showed the following coloration:

Deep light olive-green on head and back, the head bluer, then a broad lateral band of deep indigo, below this light clear green, then darker bluish-green; clear blue on lower jaw below and clear greenish-blue on lower part of cheek; lateral band becoming faint on head; a dark streak along profile from snout to nape; a dark bluish band upward and backward from eye to nape, rather conspicuous, narrowed posteriorly; dorsal indigo, edged with sky-blue; caudal green, indigo in center, yellowish at tip; anal indigo, then dull orange, then sky-blue; ventrals green; pectorals plain greenish, indigo above.

It is not unlikely that *Labrus cyanocephalus* Bloch, from unknown locality, was based on this species, as Castelnau has already suggested.

47. HALICHŒRES MACULIPINNA.

Julis maculipinna Müller & Troschel, in Schomburgk Hist. Barbadoes, 674, 1848 (Barbadoes).

Platyglossus maculipinna Günther, Cat. Fish. Brit. Mus., iv, 1862, 165 (Trinidad). Jordan, Cat. Fish. N. Am., 1885, 99 (Beaufort, N. C.). Jordan, Proc. U. S. Nat. Mus., 1886, 28 (Beaufort). Jordan & Hughes, l. c., 1886, 62 (copied).

Chœrojulis maculipinna Poey, Synopsis Pisc. Cub., 1868, 336. Poey, Enumeratio, 109, 1875 (Havana).

Pusa radiata Jordan & Gilbert, Proc. U. S. Nat. Mus., 1878, 374 (Beaufort).

Habitat.—West Indian fauna; north to Beaufort. N. C.

Etymology: *Macula*, spot; *pinna*, fin.

Of this species we have examined a small specimen taken by the *Albatross* at Port Castries, St. Lucia. From this our description has been taken. The species is closely allied to *H. bivittatus*, but is readily distinguished by the black dorsal spot and stouter form.

48. HALICHŒRES BIVITTATUS. (Plate V and VI.)

SLIPPERY DICK; DONCELLA.

Sparus radiatus Linnæus, Syst. Nat., Ed. xii, 472, 1766 (Carolina; based on a specimen from Charleston, sent by Dr. Garden). Gmelin, Syst. Nat., 1278, 1788 (copied). Walbaum, Artedi Piscium, 259, 1792 (copied). Bloch & Schneider, Syst. Ichth., 207, 1801 (copied), (not *Labrus radiatus* L., Ed. x).

Platyglossus radiatus Jordan & Gilbert, Proc. U. S. Nat. Mus., 608, 1882 (Charleston).

Labrus bivittatus Bloch, Ichth., taf. 284, fig. 1, 1792 (from a painting by Plumier, made at Martinique).

Ichthycallus bivittatus Swainson, Class. Fish., etc., 232, 1839 (name only).

Platyglossus bivittatus Günther, Cat. Fish. Brit. Mus., iv, 164, 1862 (Jamaica). Steindachner, Ichth. Notiz., vi, 49, 1867 (Barbadoes and Surinam). Cope, Trans. Am. Phil. Soc., 463, 1870 (St. Martin's). Jordan, Proc. U. S. Nat. Mus., 40, 1884 (foot-note). Jordan, Proc., U. S. Nat. Mus., 136, 1884 (Key West). Bean & Dresel, Proc. U. S. Nat. Mus., 153, 1884 (Jamaica). Jordan, Bull. U. S. Fish Com., 79, 1884 (Key West). Jordan, Cat. Fish. N. Am., 98, 1885. Jordan, Proc. U. S. Nat. Mus., 1886, 45 (Havana). Jordan, l. c., 1886, 63 (Charleston; Pensacola; Key West). Jordan, Proc. U. S. Nat. Mus., 1886, 540 (types of *Julis psittaculus* C. & V., from Surinam).

Chœrojulis bivittatus Poey, Syn., 335, 1868 (Havana).

Labrus psittaculus Lacépède, Hist. Nat. Poiss., iii, 522, 1800 (Martinique; from a copy of Plumier's painting).

Julis psittaculus Cuv. & Val., Hist. Nat. Poiss., xiii, 387, 1839 (Martinique and Surinam).

Julis humeralis Poey, Mem. Cub., ii, 212, 1860 (Havana).

Chœrojulis humeralis Poey, Syn., 335, 1868 (Havana); Poey, Enumeratio, 108, 1875 (Havana).

Platyglossus humeralis Günther, Cat. Fish. Brit. Mus., iv, 165, 1862 (Cuba); Jordan & Gilbert, Syn. Fish. N. Am., 603, 1883.

Chœrojulis humeralis Goode & Bean, Proc. U. S. Nat. Mus., 338, 1879 (Clear Water Harbor).

Chœrojulis grandisquamis Gill, Proc. Acad. Nat. Sci. Phil., 206, 1863 (Beaufort, N. C.).

Pusa grandisquamis Jordan & Gilbert, Proc. U. S. Nat. Mus., 374, 1879 (Beaufort).

Platyglossus grandisquamis Jordan & Gilbert, Syn. Fish. N. Am., 603, 1883 (copied).

Chœrojulis arangoi Poey, Enumeratio Pisc. Cub., 109, 1875 (Havana).

Platyglossus florealis Jordan & Gilbert, Proc. U. S. Nat. Mus., 287, 1882 (Pensacola).

Habitat.—West Indian fauna; Beaufort, N. C., to Brazil. Excessively abundant along rocky or weedy shores and reefs.

Etymology: *Bivittatus*, two-banded.

This species reaches a smaller size than any other of our representatives of the genus. It is also by far the most common in the waters of Florida and Cuba, and its range extends considerably farther north than any of the others.

The variations due to age and to character of the bottom are very considerable, having caused the establishment of several nominal species. In the description above mentioned by Professors Jordan & Gilbert of specimens from Charleston, Pensacola, and Key West, these variations have been sufficiently indicated. Our Cuban specimens (from coral sand) are much paler in color than those from farther north. The dark markings, however, remain similar. In old examples the dark lateral bands fade, sometimes becoming more or less broken; the

corners of the caudal become dark, and there is usually a dark spot at base of last dorsal ray. Deeper water examples are quite pale or red with distinct longitudinal stripes, and the spot at base of caudal and at base of last dorsal ray distinct.

The earliest specific name, *radiatus*, is untenable, because preoccupied. The name next in date, *bivittatus*, is based on a rather poor figure, which could, however, have been intended for no other known species. This name must therefore be retained. The name *psittaculus* was based on the same figure. The *humeralis* of Poey seems to be unquestionably the adult of this fish, common in the Havana markets, and his *arangoi* is a young example of the same, from different bottom, and showing a coloration more like our Florida specimens. The *grandisquamis* of Gill is based on an adult example in which the coloration is less sharply defined, and finally the *florealis* of Jordan & Gilbert is the gaily-colored young. None of this synonymy seems to us subject to any serious question. Besides numerous specimens from localities already recorded, we have a specimen from St. Lucia.

49. HALICHŒRES DISPILUS.

Platyglossus dispilus Günther, Proc. Zool. Soc. London, 25, 1864 (Panama); Günther, Fish. Cent. Am., 447, 1869 (Panama); Steindachner, Ichth. Beiträge iii, 64, 1875 (Acapulco); Jordan & Gilbert, Bull. U. S. Fish Com., 108, 1882 (Mazatlan); Jordan, Proc. U. S. Nat. Mus., 384, 1885 (Mazatlan) name only; Jordan, Cat. Fish. N. Am., 99, 1885; Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 64 (Mazatlan).

Habitat.—Panama fauna; Mazatlan to Panama.

Etymology: Δίς two, σπῖλος, spot.

This species has been well figured and described by Dr. Günther. It was found by Dr. Gilbert to be rather common in the rock pools about Mazatlan. It reaches but a small size. The characters in our analysis of species are taken from a specimen obtained by the *Albatross* at Panama.

50. HALICHŒRES POEYI.

Julis crotaphus Cuv. & Val., Hist. Nat. Poiss., xiii, 395, tab. 395, 1839 (Bahia), (not of Cuvier); Jordan, Proc. U. S. Nat. Mus., 1886, 541 (note on type).

Platyglossus crotaphus Günther, Cat. Fish. Brit. Mus., iv, 163, 1862 (Bahia; Jamaica); Cope, Trans. Am. Phil. Soc., 463, 1870 (St. Croix).

Chœrojulis crotaphus Poey, Enumeratio, 109, 1875 (Havana).

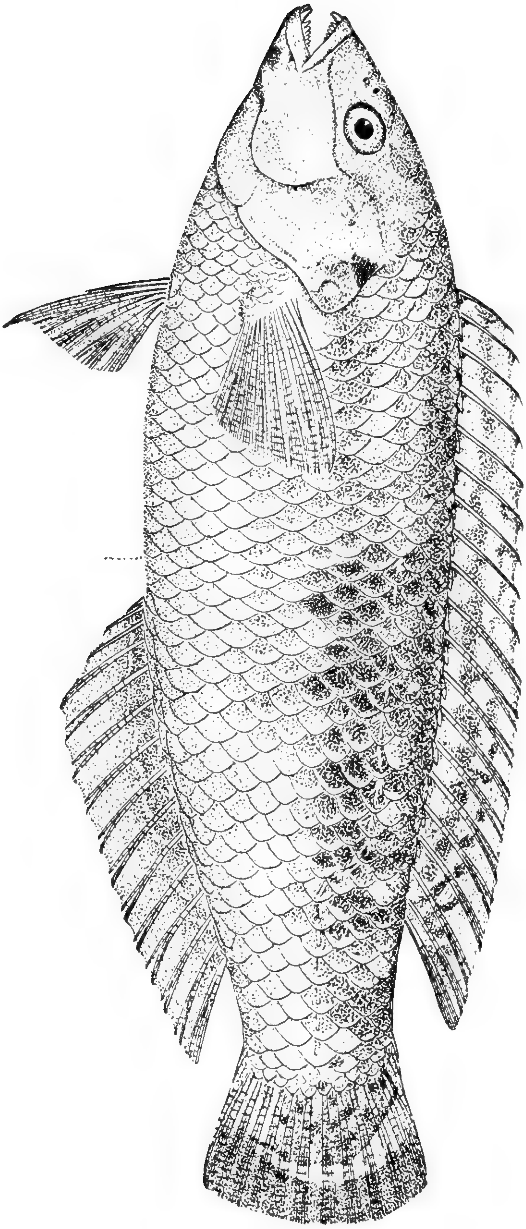
? *Platyglossus poeyi* Steindachner, Ichth. Notiz., vi, 49, 1867 (Surinam).

Habitat.—West Indian fauna; Cuba to Bahia.

Etymology: Named for Felipe Poey.

Of this species we have examined the types of *Julis crotaphus* Cuv. & Val., and three specimens taken by the *Albatross* at Bahia. The name *crotaphus* is ineligible, because originally based on *Halichœres radiatus*. The only other name which could belong to the species is that of *Platyglossus poeyi*, but our specimens do not agree well with Steindachner's description. According to Steindachner *P. poeyi* has the depth $3\frac{1}{12}$ in length, the eye "almost three" (two?) times in the snout. Lower half

 PLATE VI.



HALICHŒRES BIVITTATUS Bloch. Slippery Dick; Doncella. (Adult.)
(No. 25643, U. S. N. M.; from Charleston, South Carolina.)

of body violet-red, the upper reddish brown; on each scale above a deep blue spot; a clear blue band backward and downward from the dark preorbital spot; a second from corner of mouth; a blue crescent on base of pectoral which widens into a blue axillary spot; caudal greenish with converging streaks of yellow, edged with violet.

This species is, however, probably identical with our Bahia specimens, and so we adopt for them the name of *Halichœres poeyi*.

51. HALICHŒRES CAUDALIS.

? *Julis caudalis* Poey, Memorias Cuba, ii, 213, 1861 (Havana); Günther, iv, 191, 1862 (copied).

Platyglossus caudalis Günther, iv, 166, 1862 (copied); Jordan & Gilbert, Proc. U. S. Nat. Mus., 286, 1882 (Pensacola); Jordan, l. c., 1884, 37 (Pensacola); Jordan & Hughes, l. c., 1886, 64 (Pensacola).

? *Julis pictus* Poey, Memorias Cuba, ii, 214, 1861 (Havana).

? *Platyglossus pictus* Günther, iv, 166, 1862 (Cuba).

Habitat.—West Indian fauna; north to the Snapper Banks, off Pensacola.

Etymology: *Caudalis*, pertaining to the tail.

This species is known to us from a number of specimens, all taken from stomachs of groupers and snappers on the Snapper Banks, between Pensacola and Tampa.

We identify our specimens with the *caudalis* and *pictus* of Poey, although while agreeing in the coloration of the head and in the form of the tail with both, it differs in various details.

In *caudalis*, the depth is said to be $4\frac{1}{2}$ in the length with caudal ($3\frac{5}{6}$ without). Color, olive-green above, blue below, an olive spot on each scale; a yellow band on sides, by which the color of the back passes to that of the belly; color paler behind; head with blue bands; a green, blue-edged spot behind eye; two series of blue spots on posterior half of body; dorsal and anal rosy, with rows of blue spots.

In *pictus* the body is more slender, the depth $5\frac{1}{2}$ in total length, the eye two diameters from the corner of the mouth. Color, blue above; in front of middle of body the sides blood-red, darker on the head; behind the middle the body is olive-green; blue bands on the head; scales each with a bluish crescent; caudal with three orange bands which converge behind; dorsal and anal orange, the latter with two blue lines.

It is probable that *Julis pictus* is identical with our specimens, and perhaps *caudalis* is the female of the same, lacking the red shades on anterior half of body. In any event, we retain for the present the name of *Halichœres caudalis* for our specimens from Pensacola, placing both of Poey's species in the synonymy.

Genus XVIII.—PSEUDOJULIS.

Pseudojulis Bleeker, Proc. Zool. Soc. London, 1861, 412 (*girardi*).

Oxyjulis Gill, Proc. Ac. Nat. Sci. Phila., 1863, 330 (*modestus* = *californicus*).

TYPE: *Pseudojulis girardi* Bleeker (East Indies).

Etymology: Ψευδής, false: Julis.

This genus contains some six or eight species, closely allied to *Halichœres*, and scarcely differing from it except in the absence or rudimentary condition of the posterior canines. As in *Halichœres*, there is no sheath at the base of the dorsal. In most of the American species the anterior canines are $\frac{2}{4}$ as in the American species of *Halichœres* (subgenus *Ichthycallus*). The East Indian species have the canines $\frac{2}{2}$ as in the species of *Halichœres* found in the same region. Some of the American species of *Pseudojulis* have the dorsal spines slender and flexible.

ANALYSIS OF SPECIES OF PSEUDOJULIS.

a. Anterior canines $\frac{2}{4}$ or $\frac{4}{4}$.

b. Dorsal spines pungent.

c. Body rather stout, the depth not less than length of head, 3 to $3\frac{1}{3}$ in length; profile above eye convex; no trace of posterior canine; canines $\frac{2}{4}$; caudal fin rounded; scales before dorsal rather large, in about eight series; snout rather pointed.

d. Depth $2\frac{1}{3}$ in length; head 3; ventrals rather long, reaching nearly to vent; the inner rays $1\frac{2}{3}$ in the outer; scales 27. Color, brown, darker at bases of scales; pectorals pale; other fins black; soft dorsal, anal and caudal with white margins, broadest at tip of caudal; sometimes pale wavy lines on head.......................................ADUSTUS, 52.

dd. Depth $3\frac{1}{2}$ in length; head $3\frac{1}{2}$; ventrals short, the outer ray not nearly twice inner; scales 2–25–8. Color, olive; young with a silvery lateral streak; back with four or five indistinct broad, dark cross-bands, these forming blotches on the dorsal fin, one of these on the first three soft rays largest and quite black; angles of caudal pale; ventrals whitish, with a broad black outer margin........................NOTOSPILUS, 53.

cc. Body rather slender, its depth less than length of head, $4\frac{1}{4}$ in length; profile above eye nearly straight; head long and slender; snout long; eye small; caudal subtruncate; ventral short, its outer ray not produced; posterior canine very weak or wanting, rarely present on both sides; scales before dorsal small, in 10 or 12 series; scales on breast small; scales 2–30–8; canines slender, $\frac{4}{4}$. Color, creamy orange, the back darker; many of the scales of back and upper part of sides each with a vertically oblong dark brown spot; one of these at upper part of base of caudal more distinct than the others; a narrow dark bar across base of pectoral; a horizontal dusky streak through eye and snout; fins plain, pale; male with a vertical blue-black bar behind pectorals, much as in *Halichœres semicinctus* ....VENUSTUS, 54.

bb. Dorsal spines slender and flexible. (*Oxyjulis* Gill.)

e. Body elongate, strongly compressed; the head slender, with sharp snout; depth, $4\frac{1}{2}$ in length, less than length of head; snout, 3 in head; eye, 5; anterior canines $\frac{2}{4}$, the upper larger and divergent; posterior canine weak or wanting, rarely present on both sides; scales before dorsal much reduced, in ten or twelve rows, those on breast considerably smaller than those on sides; caudal truncate; ventrals short, the first ray not twice the length of the inner ray; scales, 28. Color, olive-brown; centers of scales orange-brown; belly cream color; sides of head with alternate streaks of brown and bluish; a large inky blotch at base of caudal, covering one-third of fin; membrane of base of spinous dorsal largely indigo-blue; fins otherwise pale; lower pharyngeals essentially as in *Halichœres*, the large teeth more acute.

CALIFORNICUS, 55.

aa. Anterior canines $\frac{2}{2}$; no trace of posterior canine. (*Pseudojulis.*)

f. Dorsal spines slender and flexible; body very slender, the depth $5\frac{1}{3}$ in length; the head $3\frac{1}{2}$; caudal truncate; pectorals and ventrals very short; scales not continuous across median line of nape; six series in front of dorsal. Color nearly uniform olivaceous; a faint dark streak forward from eye; a dark spot on each scale along base of dorsal; scales along lower half of sides edged with pale; spinous dorsal dusky; a small black spot at base of fifth ray and one at base of last ray; fins otherwise plain translucent............................INORNATUS, 56.

ff. Dorsal spines slender but pungent; body rather slender, the depth $4\frac{2}{3}$ in length; head, $3\frac{2}{3}$; caudal, rounded; pectorals and ventrals short; scales not continuous across median line of nape; eight series before dorsal. Color olivaceous, the back and sides above with seven broad dusky cross-bars, the pale interspaces less than half their width; these bars not continued on the dorsal fin; a streak forward from eye, another backward; opercular flap with a jet black spot, which has a broad, pale margin; a round black spot at base of caudal above the median rays; a dusky spot on each side above vent, in front of which are two short silvery parallel lines down and forwards with traces of four others; a small jet black spot between first and second dorsal spines; fins otherwise plain translucent.......................MELANOTIS, 57.

52. PSEUDOJULIS ADUSTUS.

Pseudojulis adustus Gilbert, Proc. U. S. Nat. Mus., 1890 (*Socorro Island*).

Habitat.—Revilla-Gigedos Islands.

Etymology: *Adustus*, browned or scorched.

This species is known from three specimens, the largest 9 inches long; taken by Dr. Gilbert on Socorro Island.

53. PSEUDOJULIS NOTOSPILUS.

Pseudojulis notospilus Günther, Proc. Zool. Soc., London, 26, 1864 (Panama); Günther, Fish. Cent. Am., 447, 1869 (Panama); Jordan & Gilbert, Bull. U. S. Fish Com., 1882, 108 and 111 (Mazatlan, Panama); Jordan, Proc. U. S. Nat. Mus., 1885, 384 (Mazatlan, Panama); Jordan, Cat. Fish. N. Am., 99, 1885; Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 66 (Panama, Mazatlan)

Habitat.—Panama fauna; Mazatlan to Panama.

Etymology: *Νῶτος*, back; *σπῖλος*, spot.

This species reaches a length of about 4 inches. Several specimens were taken by Dr. Gilbert in the rock-pools about Mazatlan, and others were found at Panama. As these specimens are not now accessible to us we have taken our analysis from the description and figure of Dr. Günther.

54. PSEUDOJULIS VENUSTUS.

Pseudojulis venustus Jenkins & Evermann, Proc. U. S. Nat. Mus., 1888, 145 (Guaymas).

Habitat.—Gulf of California.

Etymology; *Venustus*, pretty (from Venus).

This pretty little fish is known from numerous specimens collected at Guaymas by Jenkins & Evermann, and also from specimens taken in the Gulf of California by Dr. Gilbert.

55. PSEUDOJULIS CALIFORNICUS.

(SEÑORITA; PESCE REY).

Julis modestus Girard, Proc. Ac. Nat. Sc. Phil., vii, 151, 1854 (copied); Girard, U. S. Pac. R. R. Sur. Fish, 163, 1859 (San Diego, Monterey, San Miguel); Gill, Proc. Ac. Nat. Sci. Phil., 142, 1862 (foot-note), (not *Julis modestus* Bleeker).

Pseudojulis modestus Günther, Cat. Fish. Brit. Mus., iv, 168, 1862 (San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 455, 1880 (Monterey, San Diego); Jordan & Gilbert, Proc. U. S. Nat. Mus., 10, 1881 (Monterey, Santa Barbara); Jordan & Gilbert, Proc. U. S. Nat. Mus., 225, 1881 (Guadalupe Isl.); Jordan & Gilbert, Synopsis Fish, N. A., 1883, 604; Jordan, Cat. Fish, N. A., 99, 1885.

Oxyjulis modestus Gill, Proc. Ac. Nat. Sci. Phil., 331, 1863, (Coast of California).

Halichœres californicus Günther, Proc. Zool. Soc. London, 1861, (Name only; substitute for *Julis modestus*, preoccupied).

Oxyjulis californicus Jordan and Hughes, Proc. U. S. Nat. Mus., 1886, 66.

Habitat.—Coast of California; Monterey to Guadalupe Island.

Etymology: Californian.

This pretty little fish is well described in the Synopsis of the Fishes of North America above cited. It is common in the kelp along the coast of Lower and Southern California, and reaches a length of 7 inches. On the rule that "once a synonym, always a synonym," now adopted by most American ornithologists and ichthyologists, the name *modestus* must give place to *californicus*.

56. PSEUDOJULIS INORNATUS.

Pseudojulis inornatus Gilbert, Proc. U. S. Nat. Mus., 1890 (west coast of Mexico).

Habitat.—Pacific coast of Mexico.

Etymology: *Inornatus*, not adorned.

This species is known from a single specimen, 3½ inches long, dredged by the *Albatross* at station 2829, off the west coast of Mexico.

57. PSEUDOJULIS MELANOTIS.

Pseudojulis melanotis Gilbert, Proc. U. S. Nat. Mus., 1890 (west coast of Mexico).

Habitat.— Pacific coast of Mexico.

Etymology: *Μέλας*, black; *ὄυς*, ear.

This species is also known from one example. It was dredged at station 2825 by the *Albatross*.

Genus XIX.—THALASSOMA.

Julis species Cuvier & Valenciennes, xiii, 1839 (not type).
Thalassoma Swainson, Nat. Hist. Classn., Fishes, ii, 1839, 224 (*purpureus*),
Chlorichthys Swainson, l. c., ii, 1839, 232 (*bifasciatus*, etc., a jumble of species).
Julis Gunther, iv, 1862, 179, and of Bleeker (not of Swainson.)

TYPE: *Julis purpureus* Rüppell.

Etymology: *θαλασσα* (sea), green; *σῶμα*, body.

This genus as understood by us comprises numerous species, allied to *Halichœres*, but differing in the possession of but eight dorsal spines and in the absence of the posterior canine.

The anterior canines are $\frac{2}{2}$ in number in all the species seen by us,

and there is a slight scaly sheath along the base of the dorsal, as in *Platyglossus*. The anal spines are very slender. In *Thalassoma purpureum*, the type of the genus, and in all other East Indian species examined by us, the anal spines are two in number, but in all the American species which we have seen there are three. In this case the third spine is slender, resembling the soft rays. Should this character prove constant the American species may form a distinct subgenus, for which the name *Chlorichthys* should be retained. In *Thalassoma pavo* two anal spines are counted by Günther, but this character needs verification. The name *Thalassoma* was given by Swainson to a group typified by *T. purpureum*, and supposed by Swainson to be allied to *Xyrichthys*, from which it was distinguished by the form of the head and the position of the eyes. It is, however, the oldest tenable name given to this group, and must be retained, unless these related genera be reunited with *Halichœres*.

The name *Julis*, commonly used for this group, was first given by Cuvier especially to the Mediterranean species, *Labrus julis*. Other species were included with this, but by Swainson all these were removed, leaving *Labrus julis* as the type of *Julis*.

Of the American species of Thalassoma two (*nitidum* and *steindachneri*) we have not seen. The characters given below are therefore in part in need of verification.

ANALYSIS OF AMERICAN AND EUROPEAN SPECIES OF THALASSOMA.

a. Caudal fin slightly lunate in the adult, truncate in the young.

b. Body bicolor, the upper half blackish, the lower pale; body slender, the depth about 4 in length; ventrals shorter than pectorals, not filamentous; upper half of body dark purplish, the lower half abruptly rosy, the dark color of back becoming gradually deeper downward, this forming a broad blackish lateral band, the edge of which curves upward at base of caudal; a faint brown streak below the dark; middle line of back black; head black, with two streaks downward and forward from eye; dorsal dark, with whitish margin; anal brownish, distal half pale; caudal yellowish, with two purple longitudinal bands extending up on the longest rays; axil with a purple dot; tip of pectoral dark; six small scales before dorsal ....LUCASANUM, 58.

bb. Body not bicolor.

c. Body rather deep, the depth 3 to $3\frac{1}{4}$ in length, equal to length of head; nape scaled on median line; 8 or 9 scales before dorsal; ventrals short, the outer rays not produced; interopercles meeting below throat; scales 27. D., VIII, 13; A., III, 11; color deep brown, each scale on sides with a vertical bluish bar at base and margined with pale blue; sides of head thickly covered with blue spots and broken lines, those on cheek radiating from eye; dorsal and anal purplish, a submarginal pale streak and a narrow white margin; a black blotch on front of spinous dorsal; caudal brown, the outer rays tipped with black, pectorals and ventrals purplish at base with yellowish distal portion; dorsal spines, strong ....SOCORROENSE, 59.

cc. [Body slender, compressed, the depth about 4 in length; ventrals much shorter than pectorals; top of head and back brilliant yellow, this color extending on sides of head and to ventrals; a large yellow blotch on

caudal fin; lower parts rosy white; a maroon band backward from eye, breaking up on body into a series of six quadrate spots of bottle-green, the last blotch extending on outer rays of caudal; dorsal mostly greenish, with pale margin, a dark blotch between second and fifth spines; pectorals pale; ventrals yellow.] (*Goode*)..NITIDUM, 60.

aa. Caudal fin deeply forked, the outer rays much produced, especially in the adult.

d. Color not uniform deep green.

e. Pectoral fin with a large blue-black blotch near its tip.

f. [Basal half of anal violet-black; pectoral with a small black spot in the axil, and a large blotch near its tip; body greenish or reddish, each scale with a red vertical streak; a broad oblique transverse green (or bright red) band behind the pectoral from first three dorsal spines downward; head with oblique green streaks radiating from eye; dorsal green, with a very broad black longitudinal band from the third dorsal spine occupying nearly the whole of the middle of the fin; caudal lobes, each with a blackish longitudinal streak; back sometimes with black cross-bars, (var. *unimaculatum*). Head $3\frac{1}{3}$; depth $3\frac{1}{3}$; D., VIII, 13; A., II, 11; scales 3–30–11; vertebræ 11–14.] (*Günther.*) ....PAVO, 61.

ff. [Basal half of anal not violet black; head and caudal fin entirely bluish violet; edge of caudal pale; obscure paler streaks on side of head; breast to ventrals violet, paler than head; body violaceous, its anterior third paler, the scales posteriorly edged with dull violet; dorsal dull violet, its base paler, its edge whitish; anal with a violet stripe above the pale edge.] (*Steindachner*) ..........STEINDACHNERI, 62.

ee. Pectoral fin without black blotch near its tip.

g. Body bicolor, the anterior and posterior halves different; anterior half deep blue, the head paler, posterior half bottle-green, a deep blue band across body covered by pectoral; a fainter one behind gill opening, the two perhaps sometimes coalescing; spinous dorsal dark; tip of pectoral dark; caudal pale; its lobes dark blue on the outer part; soft dorsal greenish; anal and ventrals bluish.

BIFASCIATUM, 63.

gg. Body not bicolor, bright green throughout, each scale with a purplish bar at base; head, nape, and belly purplish, the head with four green streaks on each side, margined with brown; these streaks continued backwards as wavy green streaks on breast; dorsal and anal purplish, with a wide terminal green band nearly half width of fin; upper and lower caudal rays purplish, the median rays pale; pectorals and ventrals pale, a small black blotch at base of pectorals above. Head $3\frac{1}{3}$; depth $3\frac{1}{4}$; scales covering median line of nape; 7 or 8 rows before dorsal; caudal deeply lunate in adult, the outer rays twice median ones; outer ventral rays produced, not quite twice inner rays; dorsal spines pungent. D., VIII, 13; A., III, 11.

GRAMMATICUM, 64.

dd. Color uniform bright green, without well defined marks on head or body. Head 3 in length; depth about 3; scales continuous across nape; about 7 rows before dorsal; scales 27; outer caudal lobes much produced, $1\frac{1}{3}$ in head; outer ventral rays filamentous; dorsal spines pungent. D., VIII, 13; A., III, 11..............................VIRENS, 65.

58. THALASSOMA LUCASANUM.

Julis lucasanus Gill, Proc. Ac. Nat. Sci. Phil., 142, 1862 (Cape San Lucas); Günther, Cat. Fish. Brit. Mus., iv, 184, 1862 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 367, 1882 (Cape San Lucas); Jordan & Gilbert, Bull. U. S. Fish. Com., 1881.

Thalassoma lucasanum Jordan, Cat. Fish. N. Am., 98, 1885; Jordan, Proc. U. S. Nat. Mus., 1885, 384 (Mazatlan); Jordan & Hughes, l. c., 1886, 68; Jordan, Proc. U. S. Nat. Mus., 1888, 333 (Tres Marias).

Habitat.—Pacific coast of Mexico.

Etymology: From Cape San Lucas.

This little fish was found in some abundance at Cape San Lucas by Xantus, and at Mazatlan by Gilbert. It reaches a length of about $3\frac{1}{2}$ inches.

Our description is taken from three specimens brought from Tres Marias Islands by Alphonso Forrer.

59. THALASSOMA SOCORROENSE.

Thalassoma socorroense Gilbert, Proc. U. S. Nat. Mus., 1890 (Socorro Island).

Habitat.—Revilla-Gigedos Islands.

This species was found by Dr. Gilbert to be abundant about Socorro Island. The longest of the types is $10\frac{1}{2}$ inches.

60. THALASSOMA NITIDUM.

Julis nitida Günther, Cat. Fish. Brit. Mus., iv, 190, 1862 (Jamaica).
Thalassoma nitidum Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 68.
Julis nitidissima Goode, Am. Jour. Sci. and Arts, 293, 1877 (Bermuda).

Habitat.—West Indian fauna.

Etymology: *Nitidus*, shining.

This species is unknown to us. In describing *J. nitidissima*, Professor Goode indicates his suspicion that it is identical with *Julis nitida*. One can hardly think otherwise on comparing his description, taken from a single fresh specimen, with that of Dr. Günther, taken from three preserved examples. This agreement seems to us perfect when we take into account the variations to which the *Labridæ* are subject. The only tangible distinction would be in the length of the ventrals, two-thirds the pectorals in *J. nitida* and three-sevenths in *J. nitidissima.*

61. THALASSOMA PAVO.

PESCE LEONE.

Labrus pavo Hasselquist, Iter Palæstinum, 389, 1757 (Syria).
Labrus pavo Linnæus, Syst., Nat., Ed. x, 283, 1758 (after Hasselquist; confused with *Labrus bimaculatus*).
Julis pavo Cuv. & Val., xiii, 377, pl. 386; Günther, iv, 179, and of recent writers generally.
Labrus lunaris Bloch, Ichthy., plate 281, 1792 (not of Gronow).
Labrus syriacus Bloch & Schneider, Syst. Ichthy., 1801, 244 (after Hasselquist).
Labrus leo Rafinesque, Caratteri, etc., 1810, 37 (Sicily).
? *Labrus ciavolus* Rafinesque, l. c., 40.
? *Labrus imperialis* Rafinesque, l. c., 40.
Julis turcica Risso, Eur. Merid., iii, 299, 1826.
Julis unimaculata Lowe, Trans. Zool. Soc. London, iii, 11 (Madeira).
Labrus blochi Cuv. & Val., xiii, 422, 1839 (after Bloch).

Habitat.—Mediterranean Sea and shores of northern Africa.

Etymology: *Pavo*, peacock.

This species is known to us from descriptions only. This is the original *Labrus pavo* of Linnæus, and it should retain the specific name *pavo*, which should not be transferred to *Symphodus tinca*, the "*Crenilabrus pavo*" of recent authors.

62. THALASSOMA STEINDACHNERI.

? *Julis melanochir* Bleeker, Act. Soc. Sc. Indo-Nederl., ii; Amboyna, viii, 77, 1859; ? Bleeker, Atl. Ichthy., 89, tab. 33, fig. 2, 1862; Günther, Cat. Fish. Brit. Mus., iv, 182, 1862 (Amboyna); Steindachner, Ichth. Beiträge, iii, 63, 1875 (Acapulco, Sandwich Islands).

Thalassoma steindachneri Jordan, nom. sp. nov. (after Steindachner).

Thalassoma melanochir Jordan, Proc. U. S. Nat. Mus., 1886, 384 (name only); Jordan & Hughes, i. c., 1886, 68.

Habitat.—Pacific coast of tropical America; Acapulco.

Etymology: Named for Dr. Franz Steindachner, the discoverer of the species.

Dr. Steindachner observes:

An example caught at Acapulco agrees on the whole so closely with *Julis melanochir* that I can only on account of its color regard it as a variety of that species.

Julis melanochir comes very abundantly on the coast of the Sandwich Islands, and it may from thence extend its range to the west coast of North America, which, on the whole, possesses but few Labroids.

The characters in our analysis are taken from Steindachner's account of the specimen from Acapulco.

Inasmuch as the account of the Acapulco fish differs considerably from *Julis melanochir* as shown in Bleeker's figure, and as the Labroid fauna of the west coast of Mexico is in general wholly unlike that of the Western Pacific, it is probable that the fish from Acapulco is not identical with *Julis melanochir*. I have therefore given it the provisional name of *Thalassoma steindachneri*.

63. THALASSOMA BIFASCIATUM.

Labrus capite obtuso Gronow, Zoophyl., No. 243, 1781 (Antilles).

Labrus bifasciatus Bloch, Ichthy., 131, pl. 283, 1792 (East Indies); Bloch & Schneider, Syst. Ichthy., 243, 1801 (after Bloch).

Chlorichthys bifasciatus Swainson, Nat. Hist. Class'n Fish, ii, 1839, 232 (name only).

Julis bifasciata Günther, Cat. Fish. Brit. Mus., iv, 186, 1862 (Jamaica).

Julis bifasciatus Poey, Enumeratio, 107, 1875 (Jamaica).

Thalassoma bifasciatum Jordan & Hughes, Proc. U. S. Nat. Mus., 1886, 68; Jordan, l. c., 1886, 540 (types of *Julis detersor*).

Labrus bifasciatus var. *torquatus* Bloch & Schneider, Syst. Ichth., 1801, 243 (Antilles; after Gronow).

Julis detersor Cuv. & Val., Hist. Nat. Poiss., xiii, 408, 1839 (San Domingo, Martinique); Günther, iv, 186, 1862 (copied).

Labrus ornatus Gronow, Syst., ed. Gray, 83, 1854 (Antilles; after *Labrus capite obtuso*), (not of Carmichael).

Julis gillianus Poey, Mem. Cuba, ii, 214, 1860 (Cuba); Poey, Syn., 332, 1868 (Cuba).

Habitat.—West Indian fauna.

Etymology: *Bifasciatus*, two-banded.

There seems to be no doubt that *Julis detersor*, the types of which species we have examined in Paris, is identical with *Th. bifasciatum*. The

agreement is, as Poey has noticed, very close in all respects, except that implied in the remark of Valenciennes that the "spinous dorsal is low and scaly" ("basse et couverte d'écailles"). This expression doubtless refers to the scaly sheath of the fin.

64. THALASSOMA GRAMMATICUM.

Thalassoma grammaticum Gilbert, Proc. U. S. Nat. Mus., 1890, (Socorro Island; Clarion Island).

Habitat.—Revilla-Gigedos Islands.

Etymology: Γραμματικός—streaked.

This species is known from a single specimen 11½ inches long, taken by Dr. Gilbert at Clarion Island, and from numerous examples taken at Socorro Island.

65. THALASSOMA VIRENS.

Thalassoma virens Gilbert, Proc. U. S. Nat. Mus., 1890 (Socorro Island).

Habitat.—Revilla-Gigedos Islands.

Etymology: *Virens*, green.

This species, remarkable for its uniform coloration, was found by Dr. Gilbert very abundant at Socorro Island, the largest specimen being 13 inches long.

Genus XX.—DORATONOTUS.

Doratonotus Günther, Cat. Fish. Brit. Mus., iv, 124, 1862 (*megalepis*).

TYPE: *Doratonotus megalepis* Günther.

Etymology; Δόρυ, spear; νώτος, back.

This genus contains a single species of small fishes found in the West Indies. It is one of the most beautiful of the *Labridæ*, and the genus to which it belongs is one of the best defined in the group.

ANALYSIS OF SPECIES OF DORATONOTUS.

a. Body much compressed; snout rather slender and sharp; its length, $3\frac{1}{3}$ in head; maxillary, 4 in head; eye, 5 in head; cheeks and opercles scaly; dorsal spines robust and pungent, the first three with conspicuous filaments; first and second spines, including filaments, nearly equal in length, $1\frac{1}{2}$ in head; fourth spine shortest, half second; ninth highest, but somewhat shorter than the following soft rays; longest soft ray, $1\frac{2}{3}$ in head; anal spines stoutish, the longest about half head; pectorals reaching beyond ventrals; membranes of vertical fins with scales on bases; lateral line following outline of back to one scale beyond end of dorsal fin, then interrupted and continued below on four scales of caudal peduncle. Color, everywhere intense grass-green; head yellowish, some orange on tips of shorter spines and on ventrals; head, $2\frac{3}{4}$ in length; depth, $2\frac{2}{3}$; D., IX, 10; A., III, 9; scales, $1\frac{1}{2}$–20 (pores)–$6\frac{1}{2}$.
MEGALEPIS, 66.

66. DORATONOTUS MEGALEPIS.

Doratonotus megalepis Günther, iv, 125, 1862 (St. Christopher).
Doratonotus thalassinus Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 29 (Key West).

Habitat.—West Indian fauna, north to Key West.

Etymology: Μεγάς, great; λεπίς, scale.

Of this exquisite little fish only five specimens are known: (1) the

type of *D. megalepis*, a specimen in poor condition from St. Kitts; (2) the type of *D. thalassinus*, a specimen in fine condition from Key West, now in the U. S. National Museum; (3) a third specimen sent by Prof. Poey, from Havana, to the museum at Cambridge; and (4) two specimens taken by Dr. James A. Henshall at Garden Key. These last specimens have the snout less slender than it is in the original types, but this difference may be due to their greater age.

We have little doubt of the identity of *D. thalassinus* with *D. megalepis*, the slight differences in the descriptions being apparently due to the poor condition of Dr. Günther's specimens.

Genus XXI.—XYRULA.

Xyrula Jordan, gen. nov. (*jessiæ*).

TYPE: *Xyrichthys jessiæ* Jordan.

Etymology: A diminutive suggested by *Xyrichthys*.

We have separated from *Xyrichthys* one of the American species on account of the very large size of the scales, a character which, until intermediate forms are found, may be regarded as of generic value.

ANALYSIS OF SPECIES OF XYRULA.

a. Scales very large, about $1\frac{1}{2}$—20—8; anterior profile less trenchant than in other species, forming an even curve from the snout to the front of the dorsal. Eye larger than in *Xyrichthys novacula*, $4\frac{1}{3}$ in head; depth of preorbital, $2\frac{2}{3}$ in head; cheeks more than half as long as deep; canine teeth $\frac{2}{2}$, large and divergent, as in other species; lateral teeth smaller and more closely set than in *X. novacula;* dorsal spines very slender, scarcely pungent; lateral line running on the highest complete row of scales next the back, the diameter of one of its scales greater than that of the eye. Head $3\frac{1}{4}$ in length; depth $3\frac{2}{3}$. Color, uniform bright scarlet, more yellowish below, the fins similar; no blue markings anywhere..JESSIÆ, 67.

67. XYRULA JESSIÆ.

Xyrichthys jessiæ Jordan, Proc. U. S. Nat. Mus., 1887, 698 (off Tampa Bay).

Habitat.—Gulf of Mexico, in deep water.

Etymology: Named for Mrs. Jessie Knight Jordan.

This species is known from a single specimen taken by Mr. Charles H. Bollman from the stomach of some large fish in deep water off Tampa Bay, Florida. It is now in the U. S. National Museum.

Genus XXII.—XYRICHTHYS.

Xyrichthys Cuvier, Mémoires du Museum d'Hist. Nat., I., 324, 329, 1815 (*novacula*).
Novacula Cuvier, Règne Animal, Ed. i, 265, 1817 (*novacula*).
Xyrichthys Cuvier, Règne Animal, Ed. ii, 1829 (*novacula*).
Xyrichthys Swainson, Nat. Hist. Class'n Amin., ii, 1839 (*novacula*); Bleeker and Günther (not *Novacula* Gill, which is *Hemipteronotus* of Lacépède and Bleeker, a genus distinguished from *Iniistius* Gill by its scaly cheeks).
Novaculichthys Bleeker, Proc. Zool. Soc. London, 1861, 414 (*macrolepidotus*).

Malacocentrus Gill, Proc. Ac. Nat. Sci., 1862, 143 (*tæniurus*, "ventrals subjugular").
Dimalacocentrus Gill, op. cit., 1863, 223 (*kallosoma*, "first two dorsal spines more or less detached").

TYPE: *Coryphæna novacula* L.
Etymology: Ξύρον, razor; ἰχθύς, fish.

ANALYSIS OF AMERICAN SPECIES OF XYRICHTHYS.

a. Anterior profile of head simply convex, not parabolic; preorbital moderate, its depth not half of head; eye not placed very high, its diameter in the adult more than half depth of preorbital; anterior edge of head scarcely trenchant; first two spines of dorsal not pungent, more or less elevated in the young.

b. *Two anterior spines of dorsal more or less elevated, their length (in young) two-thirds that of head, their tips filamentous (*Dimalacocentrus* Gill).

c. Third and fourth spines of dorsal lowest, the spines thence slightly increasing to the last; second spine connected by a membrane with the third; caudal rounded; a series of small scales below eye; head otherwise naked. Color (male) light olive, head more yellowish; body with five brownish cross-bars, the first obscure at the nape, the last forming a blotch at base of caudal; a small yellowish spot at base of caudal, and a fainter one above it; cheeks and lower jaw banded; an olive blotch on opercle; some brown dots behind eye; dorsal cherry-red, paler posteriorly, darkest on the produced anterior rays; caudal pale; anal cherry-red, with two spots of deeper red; pectorals plain; ventrals deep cherry-red. Female, orange brown, much mottled, five cross-bands darker and broader than in the male; two yellowish brown bands across from eye over lower jaw; two similar bands across breast before ventrals; caudal and pectorals plain; ventrals deep brownish red. Head $3\frac{2}{6}$ in length; depth $3\frac{1}{5}$; D., IX, 13; A., III, 12; Lat. l. 23 or 24. ROSIPES, 68.

bb. Anterior spines of dorsal not elevated above the others in the adult (in the young slightly produced). (*Novaculichthys* Bleeker.)

c. Ventral fins much produced ending in long filaments; in the adult, $\frac{1}{4}$ longer than head and reaching much beyond front of anal; shorter in the young; a black ocellus on middle of side; depth $3\frac{1}{6}$ in length; preorbital 3 in head, $1\frac{1}{2}$ times diameter of eye; two anterior dorsal spines in adult a little shorter and less sharp than the others, which are slender but pungent; in young longer than the others; some small scales below eye. Olive, redder below, the head with sharply defined blue vertical bars alternating with yellowish ones; central part of sides with a large sharply defined inky black spot (sometimes a smaller one below it) in the center of a large silvery blotch; soft dorsal and anal with oblique bluish streaks; caudal with vertical streaks; no black ocelli on fins; young with the silvery blotch obsolete and the black spot on side nearly or quite so; the head plain, vertical fins all with oblique dark bars; back with darker cross-shades....† SPLENDENS, 69.

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* This character is of little value, as it may disappear with age. Some or all of the species called "*Dimalococentrus*" may be the young of *Novaculichthys*.

† Very closely related to *X. splendens* and to *X. rosipes* is a species described by Dr. Bean as *X. ventralis* in a paper published since the present account was written. The form of head and body is the same in the three, and *X. ventralis* and *X. splendens* agree in the prolongation of the ventrals. *X. ventralis* lacks the silvery lateral blotch and black ocellus; there is a broad red lateral shade; the stripes on the head are fewer than in *X. splendens*, and the anal and caudal are nearly plain. Perhaps this species may prove to be the adult form of *X. rosipes*.

cc. Ventral fins moderate; no black ocellus anywhere; first two dorsal spines flexible like the rest, none of them being pungent; no small scales below eye; body more elongate than in *X. novacula*, the anterior profile of the head less steep and less trenchant; head $3\frac{4}{5}$ in length; depth $3\frac{4}{5}$; scales 29. Color in spirits reddish, the fins dark (in the male); head without evident blue lines; a blue vertical streak on each scale, as in other species; no silvery blotch, and no inky spot on body (doubtful species, imperfectly described) .... *MARTINICENSIS, 70.

aa. Anterior profile of head parabolic; preorbital very deep, its depth half head; eye near top of head, its diameter not half depth of preorbital; anterior profile of head more or less trenchant; head with blue vertical stripes, at least in the male; usually a blue vertical bar on each scale. (*Xyrichthys.*)

d. Black ocellus (at least in males) present on body or fins.

e. Black ocellus, bordered with blue present on dorsal fin, behind sixth spine, none on body; a few small scales below eye; depth $3\frac{1}{4}$ in length; head 4; ventrals somewhat filamentous, their tips scarcely reaching beyond vent. Color violaceous, with a diffuse brownish cross-blotch at end of first third of body, under dorsal ocellus; dorsal and anal red; caudal yellow, with transverse violet lines, head with 12 vertical blue stripes; eye $2\frac{1}{2}$ in preorbital, which is $2\frac{1}{4}$ in head ............UNIOCELLATUS, 71.

ee. Black ocellus larger than eye and located at base of caudal, just below lateral line; none on dorsal fin; three concentric blue curved lines on flap of opercle; three narrow blue lines across cheek; a violet vertical line on base of each scale; lower jaw with numerous lines; fins pale; unmarked; female plain light brown, without markings on head or body; depth about $3\frac{1}{4}$ in length, the males deeper than the females; head $3\frac{1}{4}$; scales 2–24–9...................................MUNDICEPS, 72.

dd. No black ocellus present anywhere on body or on fins in either sex.

f. Scales of sides of body each with a vertical blue spot. General color more or less red; side of body with a diffuse silvery area below and behind the pectoral fin, often wanting or disappearing in spirits; scales below this area with pearly vertical streaks; color rose-red or brownish, with a blue vertical streak on each scale; vertical blue streaks on the head, as in other species; males (in life, always) with a dark-red cross-shade behind pectorals, this disappearing in spirits; dorsal immaculate; anal with oblique violaceous streaks; caudal with 6 or 8 dark cross-streaks. Head $3\frac{1}{2}$ in length; depth $3\frac{1}{5}$; eye small, $5\frac{1}{2}$ in head; scales 2–26–8..NOVACULA, 73.

ff. [Scales of sides of body without blue spots; head with but five vertical streaks of blue; color red, the fins nearly plain; a red axillar band, disappearing in spirits; iris red; caudal truncate; otherwise as in *X. novacula*, of which it is probably a color variety.] (*Poey.*) MODESTUS, 74.

68. XYRICHTHYS ROSIPES.

Xyrichthys rosipes Jordan & Gilbert, Proc. U. S. Nat. Mus., 1884, 27 (Key West).

Habitat.—West Indian fauna, Key West.

Etymology: *Roseus*, rosy; *pes*, foot, from the red ventrals.

Of this curious little fish only two specimens are known, both young,

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*Allied to *X. martinicensis*, or perhaps intermediate between it and *X. novacula*, is *X. infirmus* Bean. This species has the profile moderately parabolic, its edge not very trenchant; the eye nearly twice in the preorbital, and half its diameter from the profile; dorsal spines all flexible. Color olive, with blue cross-streaks and dark axil. No black ocelli anywhere.

the one male the other female. Both were taken with a seine in the surf at Key West. They are now in the U. S. National Museum. The adult will probably be found to approach *X. splendens* in form and coloration, probably having the dorsal lower and the ventrals longer than in the young.

The young of *X. splendens* has the caudal barred, while in *X. rosipes* it is plain; I have noticed no other characters by which the young of the two can be separated.

69. XYRICHTHYS SPLENDENS.

Xyrichthys splendens Castelnau, Anim. Nouv. ou Rares de l'Amer. du Sud, 1855, 28, pl. 5, 2 (Bahia).

Xyrichthys argenti-maculata Steindachner, Zool. Bot. Gesellsch. Wien, 1861, 134 (Cape of Good Hope).

Novacula argentimaculata Günther, iv, 170, 1862 (Brazil).

Habitat.—Coasts of Brazil and Southern Africa.

Etymology: *Splendens*, brilliant.

We know this species from three specimens taken by the *Albatross* at Bahia. These agree well with Günther's description of *X. argentimaculatus*, and this is probably the species for which that name was originally intended, although the original type came from the Cape of Good Hope. Its general characters are well represented in the figure of Castelnau, who, however, fails to show the silvery area around the black lateral ocellus. In one young example this black spot is very faint and the coloration is different, the back with darker cross-shades and the vertical fins all barred. In this specimen the first two dorsal spines are somewhat elevated, so as to give considerable resemblance to *X. rosipes*.

69*b*. XYRICHTHYS VENTRALIS. (Plate VII, Fig. 1.)

Xyrichthys ventralis Bean, Bull. U. S. Fish Com., 1888, 193, pl. 29, f. 1 (Cozumel).

Habitat.—West Indian fauna.

Etymology: *Ventralis*, pertaining to the belly, from the long ventrals.

This species is known from two examples taken by Dr. Bean at Cozumel Island, Yucatan. It is closely related to *X. splendens* and to *X. rosipes*, and may prove to be the adult of the latter.

70. XYRICHTHYS MARTINICENSIS.

Xyrichthys martinicensis Cuv. & Val., xiv, 49, 1839 (Martinique); Jordan, Proc. U. S. Nat. Mus., 1886, 541 (note on type).

Novacula martinicensis Günther, iv, 171, 1862.

Xyrichthys vitta Cuv. & Val., xiv, 51, 1839 (no locality); Jordan, Proc. U. S. Nat. Mus., 1886, 541 (note on type).

Habitat.—West Indies.

Etymology: *Martinicensis*, living in Martinique.

Of this species we have examined the original types of *martinicensis* and *vitta* in the museum at Paris. The two are not evidently different, although they are not in very good condition for comparison. The characters of this species are yet to be made out from fresh specimens.

70*b*. XYRICHTHYS INFIRMUS. (PLATE VII, FIG. 2.)

Xyrichthys infirmus Bean, Bull. U. S. Fish Com., 1888, 199, pl. 29, f. 2 (Cozumel).

Habitat.—West Indian fauna.

Etymology: *Infirmus*, limp, flexible.

This species is described and well figured in Dr. Bean's paper on the Fishes of Cozumel, to which the reader is referred. It is probably a near relative of *X. martinicensis*.

71. XYRICHTHYS UNIOCELLATUS.

Xyrichthys uniocellatus Agassiz in Spix, Pisc. Brazil, 97, tab. 55, 1829; Cuv. & Val., xiv, 48, 1839 (Bahia); Jordan, Proc. U. S. Nat. Mus. 1886, 541 (note on type).
Novacula uniocellata Günther, iv, 171, 1862 (Bahia).

Habitat.—Coast of Brazil.

Etymology: *Uniocellatus*, having one ocellus.

We have examined the original type of this species in the museum at Paris, and also a single example taken by the *Albatross* at Bahia.

72. XYRICHTHYS MUNDICEPS.

Xyrichthys mundiceps Gill, Proc. Ac. Nat. Mus. Sci. Phila., 1862, 143 (Cape San Lucas); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 367 (Cape San Lucas); Jordan, l. c., 1885, 384 (Cape San Lucas).
Novacula mundiceps Günther, iv, 172, 1862 (Cape San Lucas).

Habitat.—Cape San Lucas.

Etymology: *Mundus*, neat; *ceps*, head.

This species is known from numerous specimens, the original types and others, sent to the U. S. National Museum from Cape San Lucas, by Mr. John Xantus.

73. XYRICHTHYS NOVACULA. (PLATE VIII.)

(RAZOR-FISH.)

Coryphæna palmaris pulchre varia, dorso acuto Artedi, Genera, 15, 1738; Artedi, Synonymia, 29, 1738.
Coryphæna novacula Linnæus, Syst. Nat., Ed. x. 262, 1758 (after Artedi) (and of the copyists).
Xyrichthys novacula of European authors.
Coryphæna psittacus Linnæus, Syst. Nat., xii, 448, 1766 (Charleston, Dr. Garden); Gmelin, Syst. Nat. 1194, 1788; Goode & Bean, Proc. U. S. Nat. Mus., 1885, 195 (note on type).
Xyrichthys psittacus Goode & Bean, Proc. U. S. Nat. Mus., 1884, 45 (note on type of *Coryphæna psittacus*); Bean, Bull. U. S. Fish Com., 1888, 202 (Charleston, Pensacola).
Coryphæna lineata Gmelin, Syst. Nat. 1195, 1788 (Charleston, Dr. Garden).
Xyrichthys lineatus Cuv. & Val., xiv, 50, 1839 (Martinique); Jordan & Gilbert, Proc. U. S. Nat. Mus., 1882, 609 (Charleston); Jordan & Gilbert, l. c., 1883, 143 (Pensacola, name only); Jordan & Gilbert, Syn. Fishes N. Am., 605, 1883.
Novacula lineata Günther, iv, 171, 1862 (Caribbean Sea).
Coryphæna lineolata Rafinesque, Caratteri, 1810, 33.
Xyrichthys cultratus Cuv. & Val., xiv, 37, pl. 391, 1839 (Martigues, Montpellier, Ivica, Seide).

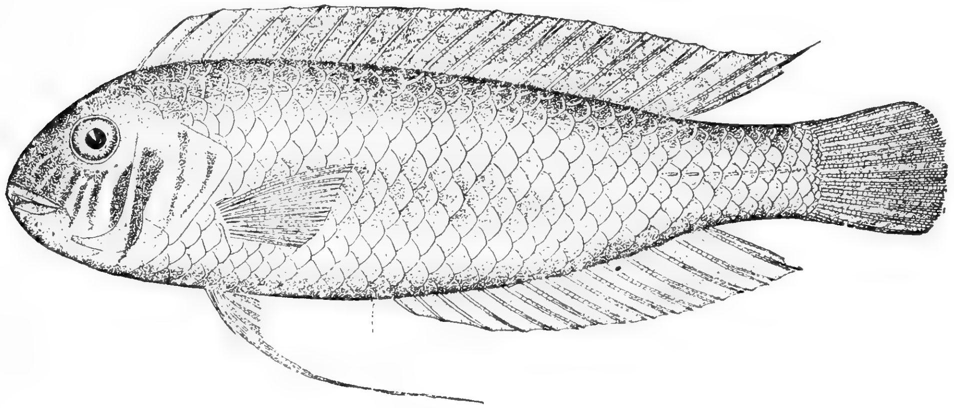


FIG. 1. XYRICHTHYS VENTRALIS Bean.

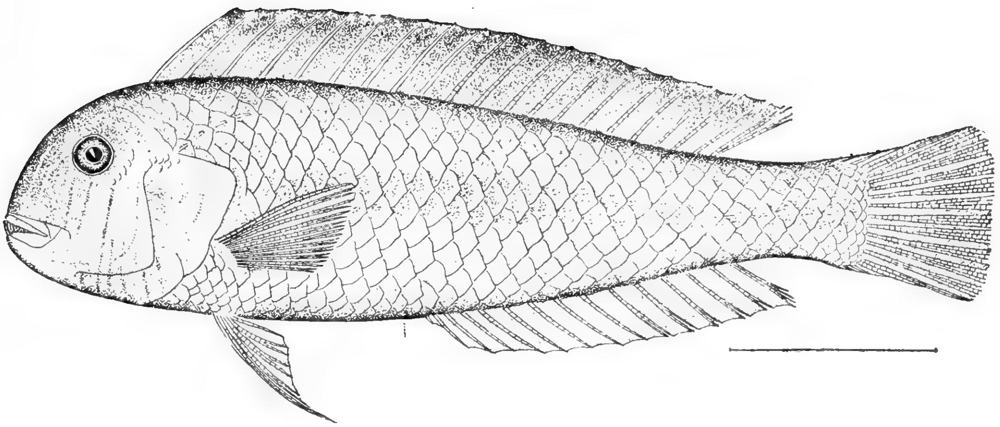


FIG. 2. XYRICHTHYS INFIRMUS Bean.

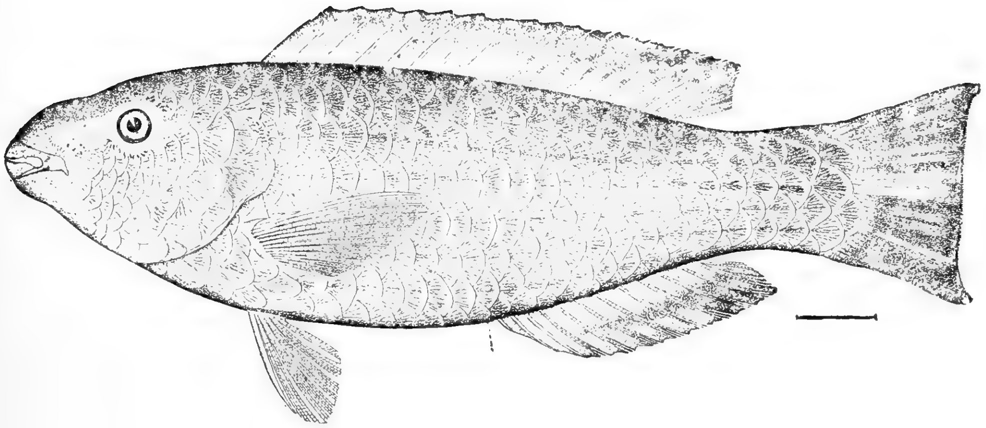
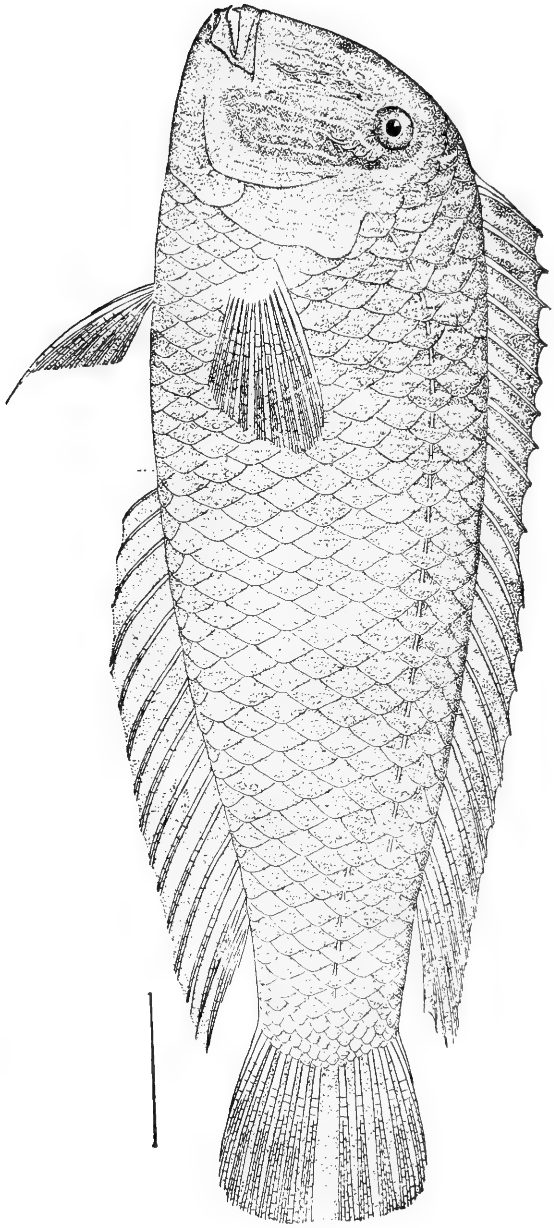


FIG. 3. SCARUS CUZAMILÆ Bean.



XYRICHTHYS NOVACULA Linnæus. Razor-fish.
(No. 5815, U. S. N. M.; from Garden Key, Florida.)

Novacula cultrata Günther, iv, 169, 1862 (Naples; Madeira; Lanzarote; Caribbean Sea; Bahia; South Africa).

Xyrichthys vermiculatus Poey, Mem., ii, 215, 1860; Poey, Repert. ii, 238, 1862; Poey, Synopsis, 336, 1868; Poey, Enumeratio, 110, 1875 (Havana); Jordan & Gilbert, Syn. Fishes N. Am., 605, 1883 (Key West); Bean, Bull. Fish Com., 1888, 202.

Xyrichthys venustus Poey, Enumeratio, 110, 1875 (Havana) (after *X. lineatus* C. & V.); Bean, Bull. U. S. Fish Com., 1888, 200 (Cozumel).

Habitat.—Mediterranean and West Indian fauna, north to Pensacola and Charleston.

Etymology: *Novacula*, razor.

We have compared numerous specimens from Pensacola and Charleston, with all the descriptions available of the Mediterranean species, and can find no difference whatever. These Charleston specimens seem to represent the *psittacus* of Linnæus and the *lineata* of Gmelin. The *vermiculatus* of Poey seems to be the same, as is also, in my opinion, his *venustus* (*lineatus* C. & V.). The white peritoneal blotch of *venustus* is evident on some of our specimens and not on others. If the above synonymy be correct, this razor-fish has a distribution unusually wide for a Labroid. Since the above was written, Dr. Bean has published an account of the American species of this genus. While recognizing the close relation of the forms in question, he admits provisionally *X. psittacus* and *X. vermiculatus* as species distinct from the common form, for which he retains the name of *X. venustus*. As, however, the types of *X. psittacus* came from Charleston, they belong, probably, to the species with the pale lateral blotch, the only species yet found in that region.

74. XYRICHTHYS MODESTUS.

Xyrichthys modestus Poey, Repert. Fis. Nat. Cuba, ii, 238, 1867; Poey, Synopsis, 336, 1868; Poey, Enumeratio, 110, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Modestus*, modest.

This species is known from Poey's description only. It seems very close to *X. novacula*, of which it is probably a color variety.

Genus XXIII.—INIISTIUS.

Iniistius Gill, Proc. Ac. Nat. Sci. Phila., 1862, 143 (*pavo*).
Xyrichthys Bleeker, Atlas Ichth., 1862, 149 (*pavo*) (not of Cuvier).

TYPE: *Xyrichthys pavo* Cuv. & Val.

Etymology: Ἴνιον, nape; ἱστίον, sail, in allusion to the first dorsal fin on the nape.

This genus contains some five or six species, chiefly of the western Pacific. They are similar in most respects to the typical species of *Xyrichthys*, differing only in having the two anterior species of the dorsal fin produced, separated from the others, and placed farther forward than in *Xyrichthys*, on the occipital region. Very close to *Iniistius* is

the East Indian genus, *Hemipteronotus* Lacépède (*Novacula* Gill, not Cuvier), which differs only in having scales upon the cheeks. It is not unlikely that it will be found necessary to unite *Iniistius*, *Hemipteronotus*, *Xyrichthys*, and *Xyrula* into one genus, as Günther has done. In this case, the name to be used is *Hemipteronotus*, not *Novacula*, nor *Xyrichthys*.

ANALYSIS OF AMERICAN SPECIES OF INIISTIUS.

a. Body deep, compressed, the profile very steep; anterior dorsal fin very high, the longest spine about $1\frac{1}{3}$ in head and $4\frac{1}{2}$ in body; height of head equal to its length; eye small, 7 in head; anterior profile steep. Color of male, olivaceous, whitish below; three broad bars of dark olive on the back and sides, these bars nearly as wide as the interspaces; most of the scales of the back and sides with a vertical, light bluish stripe; in the middle of the first dark band are one or two scales of a different color, the posterior half of each jet black, the base light blue; dorsal with narrow dark stripes running obliquely downward and backward; anal pale; a conspicuous light horizontal stripe near the tips of the rays; a narrower similar stripe near the middle of the fin; bluish clouds on opercle; vertical pale blue stripes below eye, a faint dusky streak below eye; female paler, plain, yellowish or brownish; dorsal with several oblique bars between its rays; scales 24 or 25. MUNDICORPUS, 75.

INIISTIUS MUNDICORPUS.

Iniistius mundicorpus Gill, Proc. Ac. Nat. Sci. Phila., 1862, 145 (Cape San Lucas).
Novacula mundicorpus Jordan, Proc. U. S. Nat. Mus., 1882, 367 (Cape San Lucas); Jordan, l. c., 1885, 384 (Cape San Lucas).

Habitat.—Pacific coast of Mexico.

Etymology: *Mundus*, neat; *corpus*, body.

The original types of this species (females), and later some other specimens, have been sent to the U. S. Nat. Museum from Cape San Lucas. Specimens have also been taken on the west coast of Mexico by Dr. Gilbert. The species much resembles *Iniistius pavo*, which is found in the Sandwich Islands and southward to Ceylon. Perhaps the two species are identical.

Genus XXIV.—MALAPTERUS.

Malapterus Cuv. and Val. XIII, 355, 1839 (*reticulatus*).
Malacopterus Günther IV, 88, (corrected orthography).
Neolabrus Steindachner, Ichth. Beitr. II, 19, 1875. (*fenestratus reticulatus*).

TYPE: *Malapterus reticulatus* C. & V.

Etymology: *Μαλακός*, soft; *πτερόν*, wing or fin.

This genus contains a single species, the sole representative so far as known of the subfamily *Malapterinæ*. Judging from the numbers of the fin rays, the number of vertebræ will probably be found to be increased as in the *Labrinæ*. The pharyngeal teeth have not been described, and it may be that the genus does not belong to the *Labridæ* at all.

ANALYSIS OF SPECIES OF MALAPTERUS.

a. [Body elongate; head acute; numerous scales upon cheeks in four or five rows; opercle with a series of scales upon the margin, these scales being small and ar-

ranged in three or four rows on the upper margin, large and in a single row below; center of the opercle naked; lateral line nearly parallel with base of dorsal for a distance of 30 scales, where it drops sharply, the last 10 scales being in a horizontal line; last scale of the lateral line much lengthened; scales of nape and throat small. Color reddish brown; a small, diffuse, dark blotch upon the first three dorsal rays; a second larger one, dark blue in color, generally present between the 19th and 22d soft rays of dorsal; a small, indigo-blue cross streak at base of pectoral; sides of body reticulated with dark brown lines, their junctures forming a little spot at base of each scale. Head $3\frac{4}{5}$ in length; depth $4\frac{2}{5}$. D., III, 29; A., II, 19; scales 4-40-10.] (*Steindachner.*) .... RETICULATUS, 75.

75. MALAPTERUS RETICULATUS.

Malapterus reticulatus Cuv. & Val., xiii, 355, pl. 383, 1839 (Juan Fernandez); Gay, Hist. Chili, Zool., ii, 301; Steindachner, Ichth. Beitr. iv, 62 (Juan Fernandez).
Malacopterus reticulatus Günther iv, 88 (copied).
Neolabrus fenestratus Steindachner, Ichth. Beitr., ii, 19, 1875, with plate (Juan Fernandez).

Habitat.—Coast of Chili.

Etymology: *Reticulatus*, reticulated.

This singular species seems to be rather rare on the cost of Chili. As Steindachner states that there are constantly but three simple, flexible spines in the dorsal fin, we find it necessary to remove the genus from the *Labrinæ*, where Günther has placed it, and from the *Julidinæ*, where Steindachner has left it, and to make of it a separate group or subfamily. If, as seems probable, the number of vertebræ is more than 30, the nearest allies of the *Malapterinæ* would be the *Labrinæ*. We know this species from descriptions only.

Genus XXV.—CRYPTOTOMUS.

Calliodon Cuvier, Règne Animal, 1829, Ed. ii. (*spinidens*) (not of Gronow, nor of Bloch & Schneider).
Callyodon Cuvier & Valenciennes, xiv, 285, 1830 (*spinidens, ustus*, etc.).
Cryptotomus Cope, Trans. Am. Phil. Soc., 1871, 462 (*roseus*).

TYPE: *Cryptotomus roseus* Cope.

Etymology: *Κρυπτός*, hidden; *τομός*, cutting (teeth).

This genus is closely related to *Sparisoma*, differing from it in having the anterior teeth nearly separate at all ages and in having the dorsal spines flexible, as in *Scarus*. The dentition approaches that of a very young *Sparisoma*.

The genus *Calliodon* of Gronow and of Bloch & Schneider was based on a species which apparently belongs to the genus *Scarus*. The name was transferred by Cuvier from the type of *S. croicensis* to the present group. This transfer is inadmissible in our view, and the name *Calliodon* should not be used for the genus. *Callyodon*, a variant spelling of the same word, is apparently also inadmissible.

The name *Cryptotomus* was proposed by Cope for a fish having the "dentition of *Callyodon*, but with the numerous dorsal and anal spines of the group of *Harpe*." The fin rays are given D., XI, 8; A., III, 8. The numbers in all known species of *Scarinæ* are D., IX, 10; A., III, 9 (8).

We find on examination of the original type that Professor Cope has mistaken two of the (broken) soft rays of the dorsal and one of the anal for spines. The difference between spines and soft rays in this group is very slight. We therefore regard *Cryptotomus* as a synonym of *Callyodon* Cuvier, and the latter name being ineligible, we adopt *Cryptotomus* as the name of the genus.

ANALYSIS OF SPECIES OF CRYPTOTOMUS.

Common characters.—Lower pharyngeals, upper pharyngeals, isthmus, and lateral line precisely as in *Sparisoma;* lateral teeth of upper jaw coalescent into a more or less continuous cutting edge; the teeth more separate anteriorly; free posterior canines often present; anterior teeth separate or coalescent at base only; lower jaw with a single series of partly coalescent teeth laterally, and two or more series of nearly separate teeth anteriorly; median suture of jaws not evident externally; dorsal spines flexible; jaws subequal; scales about head large, a single row on cheeks, four or five on median line before dorsal. Species of small size, mostly of dull or olivaceous coloration.

a. Posterior canines normally present (occasionally wanting on one side or both in some species).

b. Lateral teeth of lower jaw arranged in a series continuous with the anterior teeth (thus: ||||||||||||||||||||).

c. Snout long and sharp, 2 in head; the profile somewhat unevenly convex; upper lip double only posteriorly; posterior canines two, strong, recurved; anterior canines strong; teeth of lower jaw not very unequal, the anterior teeth a little longer than the middle ones, the posterior teeth little enlarged; fins rather high; head 3½; depth 3½; eye 5⅓ in head. Color in alcohol, olivaceous, the fins much mottled, the sides of the body with conspicuous pale spots; in life, "greenish, the scales yellow at base, their edges bluish; vertical fins whitish, with rosy vertical spots; caudal wine-color, with bluish vertical markings."......DENTIENS, 76.

cc. Snout shortish, its length (measured along the axis) nearly 3 in head; profile strongly convex above eye, thence nearly straight to tip of snout; posterior canine usually single, very strong; anterior canines two on each side, divergent, directed forward and outwards; lateral teeth of lower jaw very unequal, the posterior much larger than those near the middle of the side of the jaw which are wholly coalescent; eye 6 in head, its distance from angle of mouth about twice its diameter; upper lip double for its whole length; depth 3; caudal truncate. Color in spirits, olive-green, each scale with a faint brown central blotch; head nearly plain; vertical fins greenish, blotched with brown, the membranes of the first two spines blackish..................RETRACTUS, 77.

bb. Lateral teeth of lower jaw subequal, arranged in two rows which are not parallel, the posterior teeth of the anterior series standing below and outside the anterior teeth of the posterior series (thus: ||||||||||||||| ||||||||||).

d. Posterior canine usually preceded by two or three smaller ones; upper lip double for its whole length; profile slightly convex above eye and somewhat concave before it; snout long, 2⅓ in head; distance from eye to angle of mouth 3 in head, and 2⅘ times diameter of eye; eye small, 6⅔ in head; anterior canines about 4 on each side, strong and divergent; lower teeth larger than in other species; head 3 in length; depth 3. Color, in spirits, olive-gray, with irregular marblings of slaty gray; four diffuse dark blotches along base of dorsal; dorsal olive, finely mottled with darker cross-lines, the membrane of the first two spines black; caudal and anal plain olive..................USTUS, 78.

dd. Posterior canine usually single, sometimes wanting; teeth otherwise much as in *C. ustus*, the anterior canines smaller; upper lip not double for its whole length; snout sharp, the front not steep; snout $2\frac{2}{5}$ in head; eye 5; head 3; depth 3; color in life "greenish with small gilt spots arranged in oblique irregular bands on the vertical fins; a yellowish line from eye to mouth, and others on side of head."....AUROPUNCTATUS, 79.

aa. Posterior canines none; lateral teeth in each jaw subequal, those of the lower jaw larger than those of the upper and forming a continuous series.

e. Teeth of outer (anterior) series in upper jaw few, small, not canine-like, scarcely different from the lateral teeth; lower jaw without enlarged teeth; upper lip double for its entire course, the inner fold very narrow mesially; body moderately elongate, the depth $3\frac{1}{3}$ in length; head $3\frac{1}{6}$; snout rather sharp, $2\frac{4}{5}$ in head; profile gently curved, not steep; diameter of eye $4\frac{1}{2}$ in head, $1\frac{1}{2}$ in its distance from the angle of the mouth; caudal subtruncate. Color olive-gray, much mottled, sides with faint longitudinal whitish stripes; head with some greenish spots; fins pale, mottled with olive..................BERYLLINUS, 80.

ee. Teeth of anterior series in upper jaw long, canine-like, directed forward, separate to their bases; lower jaw with its anterior teeth long and somewhat canine like; upper lip double for all of its length ("on sides only," according to Cope); scales of breast and belly considerably enlarged, 3 scales before ventrals, 5 before dorsal; body slender, elongate, little compressed, the depth $4\frac{1}{5}$ in length; head $3\frac{1}{5}$; eye large, about 5 in head, more than half snout; snout very sharp, the profile straight to above eye. Caudal truncate; spines of dorsal long and very flexible; coloration nearly plain ("rosy purple" Cope); with four dark cross shades; the back vaguely barred; caudal barred with darker, a distinct blackish axillary spot; lower fins pale, probably yellow in life...ROSEUS, 81.

76. CRYPTOTOMUS DENTIENS.

Calliodon dentiens Poey, Mem. ii, 422, 1860; Poey, Syn., 344, 1868; Poey, Enumeratio, 115, 1875 (Havana).

Habitat.—West Indian fauna; Havana.

Etymology: *Dentiens*, developing teeth.

We refer to this species a specimen sent by Poey to the museum at Cambridge, our own specimens formerly called *dentiens*, apparently belonging to a different species with a shorter snout, which seems to be Poey's *retractus*.

77. CRYPTOTOMUS RETRACTUS.

Calliodon retractus Poey, Syn., 345, 1868; Poey Enumeratio, 116, 1875 (Havana).
? *Cryptotomus dentiens* Jordan, Proc. U. S. Nat Mus., 1886, 45 (Havana); Jordan l. c. 227 (Pensacola).

Habitat.—West Indian fauna, Cuba, north to Pensacola.

Etymology: *Retractus*, drawn back.

We now refer to this species the two specimens—one from Havana, the other from Pensacola, which we have formerly called *Cryptotomus dentiens*. This identification is, however, somewhat doubtful, as Poey says that the upper lip is double posteriorly only.

78. CRYPTOTOMUS USTUS.

Calliodon ustus Cuv. & Val., xiv, 286, 1839 (Brazil); Günther, iv, 214, 1862 (Trinidad; Jamaica; Bahia); Guichenot, Scarides, 59, 1865 (note on types); Jordan & Gilbert, Synopsis Fish. N. A., 1883, 606 (Charleston); Jordan, Proc. U. S. Nat. Mus., 1886, 541 (note on type).

Cryptotomus ustus Jordan, Proc. U. S. Nat. Mus., 1886, 228 (Pensacola).

Habitat.—West Indian fauna; Charleston and Pensacola to Brazil.

Etymology: *Ustus*, scorched, from the color.

We have examined specimens of this species from Rio Janeiro, Pensacola, and Charleston, as well as the original type from Brazil.

79. CRYPTOTOMUS AUROPUNCTATUS.

Callyodon auropunctatus Cuv. & Val., xiv, 290, 1839 (San Domingo); Günther, iv, 214, 1862 (copied); Guichenot, Scarides, 60, 1865 (note on type); Jordan, Proc. U. S. Nat. Mus., 1886, 542 (note on type).

Cryptotomus auropunctatus Jordan, Proc. U. S. Nat. Mus., 1886, 228.

Habitat.—West Indian fauna; San Domingo.

Etymology: *Aurum*, gold; *punctatus*, dotted.

Of this species we have examined only the original types in the museum at Paris.

80. CRYPTOTOMUS BERYLLINUS. (PLATE IX.)

Cryptotomus beryllinus Jordan and Swain, Proc. U. S. Nat. Mus., 1884, 101 (Havana; Key West); Jordan, l. c. 137 (Key West); Jordan, Proc. U. S. Nat. Mus., 1886, 45 (Havana); Jordan, l. c., 1886, 228 (Jamaica).

Sparisoma sp. Bean, Bull. U. S. Fish Com., 1888, 137 (Somers Point, N. J.), (young specimen).

Habitat.—West Indian fauna; Havana, Key West, occasionally north to New Jersey.

Etymology: *Beryllinus*, color of beryl or emerald.

This species is common about Key West on muddy bottoms. Numerous specimens of various ages were obtained, the largest about 6 inches in length. A single rather large specimen was secured in the market at Havana.

Besides the original types, we have seen a specimen from Rio Janeiro, which may be the same. It has, however, the anterior profile steeper and the eye smaller, $5\frac{1}{2}$ in head.

We have examined the young specimen described and figured by Dr. Bean as "*Sparisoma sp.*" It is identical with young specimens of *Cryptotomus beryllinus* from Key West. The occurrence of this tropical fish at a point so far to the northward is surprising.

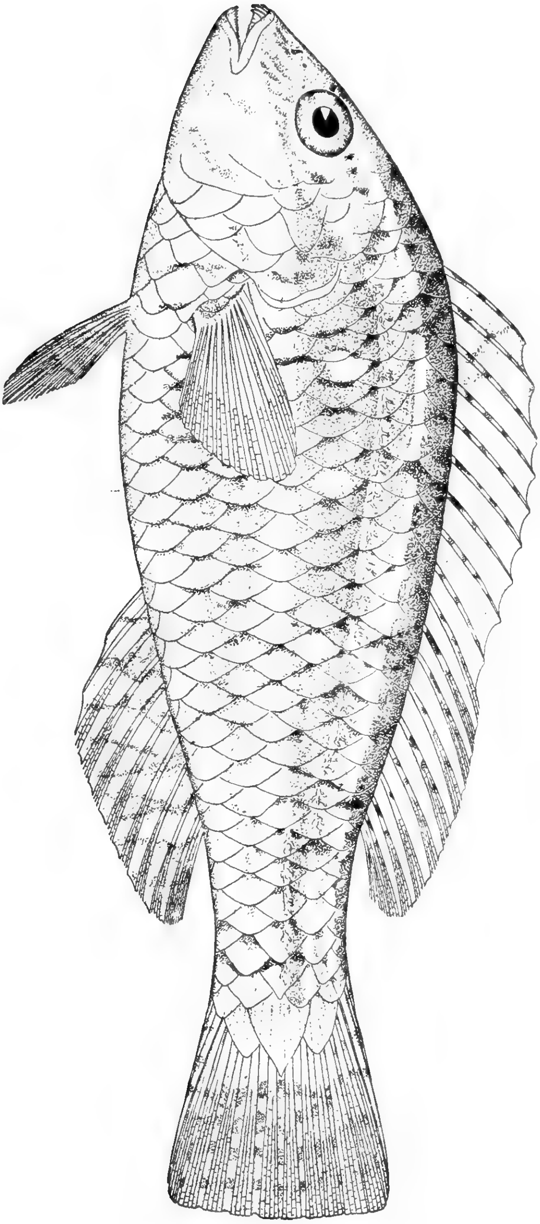
81. CRYPTOTOMUS ROSEUS.

Cryptotomus roseus Cope, Trans. Am. Phil. Soc., xiii, 462, 1869 (St. Martin's); Jordan, Proc. U. S. Nat. Mus., 1885, 545 (note on type); Jordan, Proc. U. S. Nat. Mus., 1886, 228.

Habitat.—West Indian fauna; St. Martin's; Bahia.

Etymology: *Roseus*, rosy.

Of this species we have examined the original type in the museum



CRYPTOTOMUS BERYLLINUS Jordan and Swain.

of the Academy of Natural Sciences at Philadelphia, and three smaller specimens taken by the *Albatross* at Bahia.

It is the slenderest of the Scaroid fishes, recalling such forms as *Halichœres caudalis* and *Pseudojulis californicus*.

Genus XXVI.—CALOTOMUS.

Calotomus Gilbert, Proc. U. S. Nat. Mus., 1890 (*xenodon*).

TYPE: *Calotomus xenodon* Gilbert.

Etymology: *Καλός*, beautiful; *τομός*, cutting.

This genus is based on a large Scaroid of the eastern Pacific, allied to *Cryptotomus*, but differing in the arrangment of the teeth. Some of the East Indian species referred by Bleeker to *Calliodon* are probably congeneric with *Calotomus xenodon*.

ANALYSIS OF AMERICAN SPECIES OF CALOTOMUS.

Common characters.—Teeth distinct, equal, imbricated in regular oblique rows in both jaws, wholly concealing the dental plates to the anterior edge of which they are affixed. Cutting edge of both jaws formed by the outer teeth, the dental plate not reaching the edge and visible only from within. Lips double for a short distance only. Scales of cheeks in one row; lateral line continuous; bases of dorsal and anal with scaly sheaths; dorsal spines 9, soft, and flexible; gill membranes broadly joined to the isthmus.

a. Body deep, compressed, the depth $2\frac{1}{5}$ in length; head $3\frac{1}{5}$; snout short and convex; teeth pointed, arranged in quincunx order, the posterior face alone adnate to the dental plate; teeth equal and similar in both jaws, 3 to 4 in an oblique series anteriorly; about 12 such series in the upper jaw and 14 in the lower; two posterior canines in upper jaw, curved downwards and backwards; 3 or 4 scales on cheek; four before dorsal; scales $1\frac{1}{2}$–25–7. D. IX, 10; A. III, 9. Dorsal spines high and flexible; caudal deeply lunate, the outer rays produced; ventrals short. Color mottled silvery, slaty, and brown, in indefinite pattern; pectorals dusky at base; vertical fins mottled, the dorsal and anal black on basal half. XENODON, 82.

82. CALOTOMUS XENODON.

Calotomus xenodon Gilbert, Proc. U. S. Nat. Mus., 1890 (Socorro Island).

Habitat.—Revilla-Gigedos archipelago.

Etymology: *Ξενός*, strange; *ὀδούς*, tooth.

This species is known from two specimens, the largest 14 inches long, taken by Dr. Gilbert at Socorro Island.

Genus XXVII.—CALLYODONTICHTHYS.

Callyodontichthys Bleeker, Versl. in Meddeel. Akad. Wetensch. Amsterd. Natuurk. xii, Scar., 1861, 2. (*flavescens*=*bleekeri*).

TYPE: *Callyodontichthys bleekeri* Steindachner.

Etymology: *Καλός*, beautiful; *ὀδούς*, tooth; *ἰχθύς*, fish.

This genus contains a single species, of which but one specimen has been made known. We have never seen it, and do not know whether it is the representative of a distinct genus, or whether it be simply the young of a species of *Sparisoma*.

83. CALLYODONTICHTHYS BLEEKERI.

Callyodontichthys flavescens Bleeker, Scarid., 2, 1861 (Bahia), not *Scarus flavescens* Bleeker).

Callyodontichthys bleekeri Steindachner, Ichthyol., Mittheilungen, v, 1862.

Habitat.—Coast of Brazil.

Etymology: Named for Pieter van Bleeker.

This species is unknown to us, and we are unable to give any of its specific characters.

Genus XXVIII.—SPARISOMA.

Sparisoma Swainson, Nat. Hist. Class'n, Fishes, etc., 1839, ii, 227 (*abildgaardi*).

Scarus Bleeker, Versl. Akad. Wet. Amsterdam, xii, 1861, Scaroid, 3 (*cretensis*).

Scarus Günther, Poey, Guichenot et Auct. (*cretensis*).

Sparisoma Jordan & Gilbert, Syn. Fish. N. A., 1883, 938 (*abildgaardi*).

TYPE.—*Sparus abildgaardi* Bloch.

Etymology: *Σπάρος*, Sparus, ancient name of some Sparoid fish; *σῶμα*, body. Sparus is said to be from *σπαίρω*, to gasp.

We have elsewhere given the reasons which have led us to retain the name *Scarus* for the group (*Pseudoscarus*) to which the species originally described as *Scarus* by Forskål belong.

This being done, the only name applicable to the present group is that of *Sparisoma* Swainson. As originally defined this generic name was a useless synonym, like nearly all the other generic names of fishes proposed by Swainson. It was supposed to differ from the *Petronason* of the same author in the presence of hexagonal scales, sharp incisive teeth and obtuse canines. As, however, its type, *S. abildgaardi*, is a member of the present genus, the name should not be set aside.

ANALYSIS OF SPECIES OF SPARISOMA.

Common characters.—Lower pharyngeal broader than long, subhexagonal, its surface moderately concave or flattish; teeth in each jaw largely coalescent in the adult, their tips more or less separate in the young, the edge, especially of the lower jaw, remaining uneven; the median suture in each jaw present, but not well defined; one to four radiating canines sometimes present on each side of upper jaw above its cutting edge;* gill membranes broadly united to the isthmus; dorsal spines pungent; upper lip double for its entire length; lower jaw projecting beyond upper; lateral line not interrupted, passing gradually from its row of scales posteriorly to the series next below it; tubes of lateral line much branched; scales about head large, those on cheek in a single row, those on the median line in front of dorsal three or four in number. Species of rather small size, most of them American.

a. Upper jaw never with posterior lateral canines.

b. Caudal slightly rounded, the angles not produced.

y. Scales of lateral line and nape not black; cheeks with three scales. Color purple or purplish-brown, with brownish shade on anterior part of body, this shade forming generally a large, distinct, dark blotch between the pectoral and lateral line; caudal violet, with a white band at tip and obscure cross-bars. CRETENSE, 84.

*In some species having normally one or more canine teeth, some or all of them are occasionally absent—on one or both sides.

yy. [Scales of the lateral line, those on the nape of the neck, and a few on the opercles, black shining violet; dorsal spines stout, the anterior not much longer than the orbit. General color, olive (in spirits); outer parts of the vertical fins, violet; posterior part of the axil, blackish violet.] (*Günther.*) .... STRIGATUM, 85.

bb. Caudal lunate, or truncate with sharp angles (rounded in the very young).

c. Caudal fin distinctly barred with irregular brown spots and markings.

d. Body without distinct pale longitudinal streaks above; caudal not evidently pale-edged; spot on base of pectoral blackish and distinct; no evident pale or dark blotches on back of tail; caudal lunate or (var. *truncatus*) truncate in adult, rounded in young. General color olivaceous or reddish brown, clouded, and washed with cherry-red; lower fins mostly red; pectorals light orange; chin pale, with a whitish cross-band............ FLAVESCENS, 86.

dd. Body with three or four pale longitudinal streaks, the upper running to a faint pale blotch on back of tail between two dark brown blotches; caudal distinctly pale-edged behind and more distinctly barred than in *S. flavescens*; spot at base of pectoral brownish and very faint; about four small dusky blotches along base of dorsal, the last one most distinct at base of last ray; caudal with many cross-bars and blotches; snout dusky; chin with one or two whitish cross-bars; caudal concave, with sharp angles; dorsal and anal mottled with brown; pectorals and ventrals plain; young with dark opercular blotch and dark points about eye ... FRONDOSUM, 87.

cc. Caudal fin not cross-barred.

d. Axillary spot black, very distinct; outer rays of caudal considerably produced, the length of exserted part one-third to one-half that of head.

e. Caudal red, its outer rays green; axillary spot very distinct; body olivaceous, nearly plain, reddish below; some greenish blue on head; a faint greenish streak running backward from the angle of the mouth............ BRACHIALE, 88.

ee. [Caudal violaceous; outer rays of caudal produced to about one-half the length of the head; a dark spot at base of pectoral. General color dusky red; fins yellowish red; scales of the back and sides with many red spots.] (*Bleeker.*) MASCHALESPILOS, 89.

dd. Axillary spot faint or wanting; coloration uniform dark purplish-violet; three large scales on cheek; dorsal spines rather slender but pungent; caudal emarginate; tubes of each scale of lateral line much ramified and extending over the whole scale; teeth of moderate size, very distinct on the edges of the jaws.] (*Günther.*) .... ARACANGA, 90.

aa. Upper jaw with one or more canines above its cutting edge (these occasionally obsolete on one or both sides).

g. Caudal fin in adult deeply forked, the upper lobe about as long as the head, and twice or more the length of the inner rays; caudal fin variegated.

h. Canines 3 or 4 on each side; pores of lateral line excessively branched, each with several (6 to 8) much divided branches. Color bright greenish blue (the side sometimes with a

blue band); caudal lobe blue, the middle rays red; dorsal and anal red; pectorals yellowish, the axillary spot large, black, edged with red..CHRYSOPTERUM, 91.

hh. Canines one or two on each side; upper and lower caudal lobes greenish.

i. Opercle without black and yellow spot, pores of lateral line each with few (4 or 5) nearly simple branches. Color in life chiefly light blue, without sharp markings, fading to reddish in spirits; caudal dull greenish, the middle rays reddish; other fins mostly scarlet; axillary spot well defined..................................LORITO, 92.

ii. Opercle with an inky black spot, in front of which is a golden spot; one short blunt canine; no spot at base of pectoral; axil dark within; a white blotch near root of caudal; gill membranes red; pectorals dark green posteriorly; anal green at base and at margin, brownish in the middle; caudal with a red crescent, separated by a green band from the transparent posterior margin.
VIRIDE, 93.

gg. Caudal fin simply lunate, the outer rays more or less exserted, but not twice as long as the inner rays and much shorter than the head; canine single on each side (rarely obsolete or duplicated).

q. Body largely red in life; no pale blotch on back of tail.

j. Head with a scarlet stripe from below eye to angle of mouth; a small scarlet streak behind eye; color chiefly purplish brown; a round spot of yellow and black behind head, just below lateral line; fins chiefly red; angles of caudal black; axillary spot obscure.
AUROFRENATUM, 94 *b.*

jj. Head unstriped; color dark reddish brown, with white mottlings; no yellow or black spot; belly abruptly red; fins mostly cherry red; axillary spot obsolete; body rather deep; scales large, their outlines well defined.
ABILDGAARDI, 95.

qq. Body with little or no red in life; a pale blotch on back of tail; axillary spot faint; caudal barred; body with 3 or 4 pale lengthwise streaks ....DISTINCTUM, 95 *b.*

ggg. Caudal truncate or slightly rounded; the angles not acute.

z. Posterior canine single on each side; body rather stout. Color grayish olive, closely speckled with whitish and dusky; lower half of body abruptly paler from level of eye; upper half with a narrow whitish stripe confluent with the back from nape to end of dorsal; the part of back below this crossed by irregular dusky bars which end abruptly at level of eye; lower half with obscure pale lengthwise streaks; a black spot as large as pupil on end of opercle; axil and base of pectoral dark; dorsal gray, throughout mottled with pale and vaguely barred and spotted with blackish; caudal dark olive, with narrow pale cross-bars; a broad olive cross-bar at base; anal colored like soft dorsal; ventral faintly barred; pectoral plain; chin with two broad silvery cross-bars, and two irregular bars of dark olive ....NIPHOBLES, 96.

zz. Posterior canines 2 to 4 on each side.

l. Caudal fin without black in the adult; one or two more or less distinct whitish bars across the chin.

m. Canines 2 or 3 on each side; axillary region extensively deep blue in life, this forming a large blotch around and on base of pectoral; a curved series of small white specks around the blue on base of pectoral; body deep and robust; fins all mottled, the anal with three darker areas; body with three faint pale lengthwise streaks, more or less obscure; two of these bound a more or less interrupted dusky band from eye to base of caudal. HOPLOMYSTAX, 97.

mm. Canines 4 (rarely 3) on each side radiating horizontally; axil with little or no blue, but with a dusky blotch partly hidden by the fin; front steeper and less curved than in *hoplomystax;* body and fins mottled, but much less so than in the preceding; a distinct narrow streak of blue downward and forward from eye; caudal nearly plain, dusky olive; anal mottled.. RADIANS, 98.

ll. Caudal fin with more or less of black on posterior margin, yellowish at base; anal light bluish and reddish; its tip dusky; canines strong, 4 (rarely 3) on each side; 4 or 5 scales on cheeks. Color olive green above, mottled and speckled with red; snout with blue lines; a blue band around lower jaw; axil and base of pectoral deep blue-black; fins mostly light orange and yellow. XYSTRODON, 99.

84. SPARISOMA CRETENSE.

Scarus (Σκάρος) of the ancients.

Labrus ex purpureo viridi cœruleo et nigro varius Artedi, Synonomia, 55, 1738.

Labrus tetraodon virescens, cauda bifurca Artedi, Syn., 57.

Labrus cretensis Linnæus, Syst. Nat., Ed. x, 1758, 282 (after Artedi, 57) (and of the copyists).

Scarus cretensis Cuv. & Val., xiv, 164, pl. 400, 1839; Günther, iv., 209, and of most recent authors.

Labrus varius Linnæus, Syst. Nat., Ed. x, 282, 1758 (after Artedi Syn., 55).

Labrus xantherythrus Rafinesque, Caratteri, etc., 1810, 40.

Scarus rubiginosus Cuv. & Val., xiv, 171, 1839.

Scarus mutabilis Lowe, "Trans. Zool. Soc., ii, 187."

Scarus canariensis Valenciennes, "Webb & Berthelot, Ichth. Iles Canaries, pl. 17, f. 2." (Canary Islands).

Scarus siculus Cocco, (*fide* Bonaparte).

Habitat.—Mediterranean Sea and neighboring islands.

Etymology: *Cretensis*, living in Crete.

This species, the original *Scarus* of the ancients and the only Scaroid fish found in European waters, is rather rare in the Mediterranean Sea. Our specimen was sent from Palermo by Dr. Pietro Doderlein.

85. SPARISOMA STRIGATUM.

Scarus strigatus Günther, iv, 212, 1862 (locality unknown).

Habitat.—Unknown.

Etymology: *Strigatus*, striped.

Very little is known of this species. As the genus *Sparisoma* is chiefly confined to American waters, we include the species in the present paper as possibly American.

86. SPARISOMA FLAVESCENS.

Vieja Parra, Descr. Piezas Dif. Hist. Nat., 1787, 59, pl. 28, f. 4 (Cuba).

Scarus flavescens Bloch & Schneider, Syst. Ichth., 1801, 290 (after Parra); Poey, Enumeratio, 1875, 113 (identification of *Sc. squalidus* with Parra's figure); Jordan, Proc. U. S. Nat. Mus., 1884, 137 (Key West).

Callyodon flavescens Cuv. & Val., xiv, 288, 1839 (after Parra).

Sparisoma flavescens Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 92 (Havana, Key West); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana); Bean, Bull. U. S. Fish Com., 1888, 198 (Cozumel).

Scarus rubripinnis Cuv. & Val., xiv, 199, 1839 (San Domingo); Günther, iv, 211 (copied); Guichenot, 13, 1865 (copied); ? Cope, Trans. Am. Phil. Soc., 1871, 462 (St. Croix).

? *Scarus virens* Cuv. & Val., xiv, 203, 1839 (Porto Rico; Martinique).

Scarus squalidus Poey, Mem., ii, 218, 1860 (Cuba); Poey, Synopsis, 338; Jordan & Gilbert, Syn. Fish. N. A., 1883, 938 (Garden Key); Günther, iv, 212, 1862, (copied).

? *Scarus chloris* Guichenot, Scarides, 1865, 14 (San Domingo, type of *Scarus virens*; not of Bloch & Schneider).

? *Scarus truncatus* Poey, Synopsis, 1868, 339 (Havana); Poey, Enumeratio, 1875, 114; Poey, Fauna Puertó-Riqueña, 308, 1878 (Puerto Rico).

Habitat.—West Indian fauna, Key West to Brazil.

Etymology: *Flavescens*, yellowish.

This species is excessively common at Key West, swarming everywhere about the island in the eel-grass. It rarely exceeds a foot in length. At Havana it is apparently equally common, the numbers seen in the market exceeding that of all the other species combined. It is one of the least brightly colored of the species of the genus. As a food fish, this, like the others, is held in low esteem. The flesh, although not unpleasant in flavor, is soft and rather poor. In the Havana market it is usually called *Vieja colorada*, but the species of this group are seldom distinguished by fishermen. In the museum at Cambridge are specimens of *Sp. flavescens* from St. Thomas, Jérémie, Hayti, Port au Prince, Tortugas, Nassau, and Rio Janeiro. It was found in abundance at St. Lucia by the *Albatross*.

We follow Poey in identifying with this species the *Vieja* of Parra, which is made the type of *Scarus flavescens* of Schneider. Valenciennes has made of this "Vieja" a *Calliodon*, and Bleeker a *Callyodontichthys*. Parra's figure seems not unlike this species, but we should not have ventured so to consider it except for the authority of Poey. There seems to be little doubt that this species is the original *Scarus rubipinnis*, as well as the *Scarus squalidus* of Poey. The *Scarus virens* C. & V., and *Scarus truncatus* of Poey either belong to this species or to some one very closely related to it, possibly distinguished by a truncate caudal. In the form of the caudal this species shows some variation.

If the name *flavescens* is considered too uncertain for adoption, *Sparisoma rubripinne* comes next in order of time.

There is considerable variation in the amount of redness in this species large ones being usually more rosy than the young.

87. SPARISOMA FRONDOSUM.

Scarus frondosus (Cuvier MSS.) Agassiz, Spix. Pisc. Brazil, 1829, 98 (Brazil); Cuv. & Val., xiv, 204, 1839 (Bahia, etc.); Guichenot, Scarides, 1865, 15 (Bahia); Jordon, Proc. U. S. Nat. Mus., 1886, 542 (note on type); Günther, iv, 210, (Cuba; Jamaica; Trinidad; Brazil).

? *Scarus circumnotatus* Poey, Mem., ii, 423, 1860; Poey, Repert. i, 375, 1866; Poey, Syn., 340, 1868; Poey, Enumeratio, 114, 1875 (Havana).

? *Scarus emarginatus* Poey, Syn., 340, 1868; Poey, Enumeratio, 114, 1875 (Havana).

? *Scarus distinctus* Poey, Mem., ii, 423, 1860; Poey, Repert. ii, 163, 1867; Poey, Syn., 341, 1868; Poey, Enumeratio, 114, 1875 (Havana).

Habitat.—West Indian fauna, Cuba to Bahia.

Etymology: *Frondosus*, branched.

Our description is based on specimens taken by the *Albatross* at Bahia. These seem to correspond to the species called *frondosus* by Günther and probably to the *distinctus* of Poey. The types of *frondosus* are from Bahia also and are either this species or else *flavescens*, the former supposition being the most probable. The type of *Sparisoma distinctum* has a lateral canine. It may be a distinct species from *frondosum*, or it may be that this is one of the species normally possessing canines.

I can not separate the *circumnotatus* or the *emarginatus* of Poey from *S. frondosum*, and so place them doubtfully in the synonymy.

The relations of *frondosum* to *flavescens* are very close.

88. SPARISOMA BRACHIALE.

Scarus brachialis Poey, Memorias, ii, 345, 1860 (Cuba); Poey, Synopsis, 337 (misprinted *braguialis*); Poey, Enumeratio, 113 (Havana).

? *Scarus humeralis* Poey, Mem., ii, 422, 1860; Poey, Syn., 342, 1868; Poey, Enumeratio, 113, 1875 (Havana).

Sparisoma frondosum Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 93 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana), (not *Scarus frondosus* Cuvier).

Habitat.—West Indian fauna; Havana.

Etymology: Βραχίων, the arm, from the axillary spot.

A single specimen of this species was obtained at Havana. Its life colors were not noticed. In spirits its colors are quite different from those of *S. flavescens*, though in other respects the two bear much resemblance.

89. SPARISOMA MASCHALESPILOS.

Scarus maschalespilos Bleeker, Notices Ichthyologiques, i–x, 5, 1862 (Surinam).

Habitat.—West Indian fauna; Surinam.

Etymology: Μασχάλη, arm-pit; σπῖλος, spot.

This species is known from the original description only. It is perhaps distinct from *S. brachiale*, though evidently closely allied.

90. SPARISOMA ARACANGA.

Scarus aracanga Günther, iv, 209, 1862 (Jamaica).

Habitat.—West Indies.

Etymology: *Aracanga*, Portuguese name of a large parrot in Brazil.

This species is known from Günther's scanty description only. We are indebted to Mr. G. A. Boulenger for the information that in the types of *Sparisoma strigatum* and *S. aracanga*, there are no posterior canines.

It is not certain that this species is distinct from *frondosum* or from *brachiale*.

91. SPARISOMA CHRYSOPTERUM.

Vieja Parra, Descr. Dif. Piezas Hist. Nat., 1787, 58, pl. 28, f. 4, (Cuba).

Scarus chrysopterus Bloch & Schneider, Syst. Ichth., 1801, 286, pl. 57 (American seas); Cuv. & Val., xiv, 185, 1839 (St. Thomas); Günther, 1862, 12 (Martinique; Jamaica); Guichenot, Scaridés Mus. Paris, 12, 1865 (San Domingo; Guadeloupe); Cope, Trans. Am. Philos. Soc., 1871, 462 (St. Croix; St. Kitts).

Sparisoma chrysopterum Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 94 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).

Scarus chloris Bloch & Schneider, Syst. Ichth., 1801, 289 (after Parra); Goode, Bull. U. S. Nat. Mus., v, 1876, 34 (synonymy).

Scarus lateralis Poey, Memorias, ii, 219, 1860 (Cuba); Poey, Repertorio, i, 373, 375; ii, 162; Poey, Synopsis, 337; Poey, Enumeratio, 112.

Scarus spinidens Guichenot, Scaridés, 15, 1865 (Bahia).

Habitat.—West Indian fauna.

Etymology: *Χρυσός*, golden; *πτερόν*, wing or fin.

A single rather large specimen was obtained by Dr. Jordan in the Havana market. We have also examined specimens from St. Thomas. There has been no disagreement among recent writers as to the synonymy of this species. Goode, in adopting for it the name *chloris*, has overlooked the slight priority of *chrysopterum*, and Poey has preferred to set both aside on account of imperfections in the description and of the error involved in the name of *chrysopterum*, none of the fins being really golden.

The identification of Parra's figure has been rendered certain by a colored drawing of the original type of Parra, sent by Graëlls to Poey, and by him presented to me.

The original figure of this species, published by Bloch & Schneider, is very incorrect as to form, but not uncharacteristic as to color or dentition. It may have been made from a dried and distorted skin.

92. SPARISOMA LORITO.

Sparisoma lorito Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 95 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).

Habitat.—West Indian fauna.

Etymology: *Lorito*, Spanish diminutive of loro, parrot.

The single original type came from Havana. Others are in the mu-

seum at Cambridge from St. Thomas, Sombrero, Barbadoes, and Jérémie, Hayti. Although it is evidently not a rare species, we are unable to identify it with any of those described by Poey, or by Cuvier and Valenciennes.

93. SPARISOMA VIRIDE.

Piscis viridis bahamensis [the parrot fish] Catesby, Nat. Hist. Car., ii, 29, pl. 29, 1738 (Bahama).
Scarus viridis Bonnaterre, Enc. Meth., x, 96, 193, 1788 (after Catesby) (not *Scarus viridis* Bloch, 1790).
Scarus catesby Lacépède, iv, 16, 1803 (after Catesby).
Scarus catesbæi Cuv. & Val., xiv, 183, 1839.
Scarus catesbæi Poey, Repert., i, p. 372, 1867; Guichenot, Scaridés, ii, 1865 (San Domingo; Guadaloupe); Günther, iv, 210, 1862, South America, West Indies).
Scarus catesbyi Poey, Enumeratio, 110, 1875.
Sparisoma catesbyi Bean & Dresel, Proc. U. S. Nat. Mus., 1884, 153 (Jamaica).
Sparisoma catesbæi Jordan, Proc. U. S. Nat. Mus., 1884, 191.
Callyodon psittacus Gronow, ed. Gray, 84, 1854 (not of Linnæus).
Scarus melanotis Bleeker, Notices Ichthyologiques, i–x, 4, 1862 (St. Croix).

Habitat.—West Indies.

Etymology: *Viride*, green.

This is one of the largest and most strongly marked of the parrot-fishes. In the museum at Cambridge are specimens from Sombrero Key and St. Thomas.

The name *Scarus viridis* has priority over *Scarus catesby*—both names having been based on Catesby's figure, which is more exact than most of the early plates of fishes.

The *Scarus melanotis*, likewise distinguished by a black and yellow opercular spot, seems to us to be identical with *Sparisoma viride.*

94. SPARISOMA AUROFRENATUM.

Scarus aurofrenatus Cuv. & Val., xiv, 1839, 191 (San Domingo); Günther, iv, 212 (Cuba, Jamaica, Trinidad); Guichenot, Scarides Mus. Paris, 1865, 13 (San Domingo); Cope, Trans. Am. Philos. Soc., 1871, 46 (St. Croix, St. Martin's).
Sparisoma aurofrenatum Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 96 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).
Scarus miniofrenatus Poey, Memorias, ii, 279, 393, 1860 (Cuba); Poey, Repertorio, i, 1867, 374; ii, 164, 1868; Poey, Synopsis, 337; Poey, Enumeratio, 1875, 111.

Habitat.—West Indies.

Etymology: *Aurum*, gold; *frænatus*, bridled; in allusion to the scarlet band backward from the mouth.

This species is rather common in Havana, where three specimens were obtained. Others are in the museum at Cambridge from Cuba, Sombrero, and St. Thomas. Specimens were obtained at St. Lucia by the *Albatross.* In color it is one of the most strongly marked and handsomest species. The name *aurofrenatum* is rather unfortunate, as the stripe on the head is bright vermilion in life. This, however, does not justify the substitution for *aurofrenatum* of the name *miniofrenatus* of Poey.

95. SPARISOMA ABILDGAARDI.

Vieja Parra, Descr. Dif. Piezas Hist. Nat., 1787, 58, pl. 28, f. 2 (Cuba).
Scarus abildgaardi Bloch, Ichthyol., taf. 259, 1791 ("America," from a specimen sent by Prof. Abildgaard); Lacépède, Hist. Nat. Poiss., iv, 55, 163, 1802 (copied).
Scarus abildgaardi Cuv. & Val., xiv, 175, 1839 (St. Thomas, Bahia); Günther, iv, 209 (Puerto Cabello); Guichenot, Scaridés, Mus. Paris, 10 (Bahia, San Domingo); Poey, Repertorio, i, 371, 1867, ii, 160; Poey, Synopsis, 337; Poey, Enumeratio, iii; Cope, Trans. Am. Philos. Soc., 1871, 461 (St. Croix, St. Martin's).
Sparisoma abildgaardi Swainson, Nat. Hist. Class'n, Fishes, etc., ii, 1839, 227; Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 97 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).
Scarus coccineus Bloch & Schneider, Syst. Ichthyol., 1801, 289 (after Parra); Cuvier, Règne Animal, 1829, Ed. ii.
Scarus aureoruber Lacépède, Hist. Nat. Poiss., iv, 55, 163, 1803 (on a drawing by Plumier).
Scarus amplus Ranzani, "Nov. Comm. Acad. Scient. Inst. Bonon. t. 5, p. 324, pl. xxv, 1842" (*fide* Guichenot).
Scarus erythrinoides Guichenot, Scarides, Mus. Paris, 10, 1865 (San Domingo).
Scarus oxybrachius Poey, Synopsis, 1868, 342 (Cuba); Poey, Enumeratio, 115, lam. 14, f. 2.

Habitat.—West Indies.

Etymology: Named for Abildgaard, professor in the University of Copenhagen.

Several specimens of this species were obtained at Havana, where it is not uncommon. We have also seen specimens from St. Thomas and St. Lucia.

This is evidently the original *Sparus abildgaardi* of Bloch. The *Scarus coccineus* of Bloch & Schneider seems to belong certainly here. The description given by Guichenot of his *Scarus erythrinoides* fits our specimens well; better than his account of *Scarus abildgaardi*. We do not see that Poey's *Scarus oxybrachius* can be different. The sharpness of the pectoral is probably merely accidental. The pectoral is a little longer in proportion to the head in this species than in most others, but this difference seems to be due to the fact that the head is rather shorter.

The description of *Scarus amplus* we have not seen.

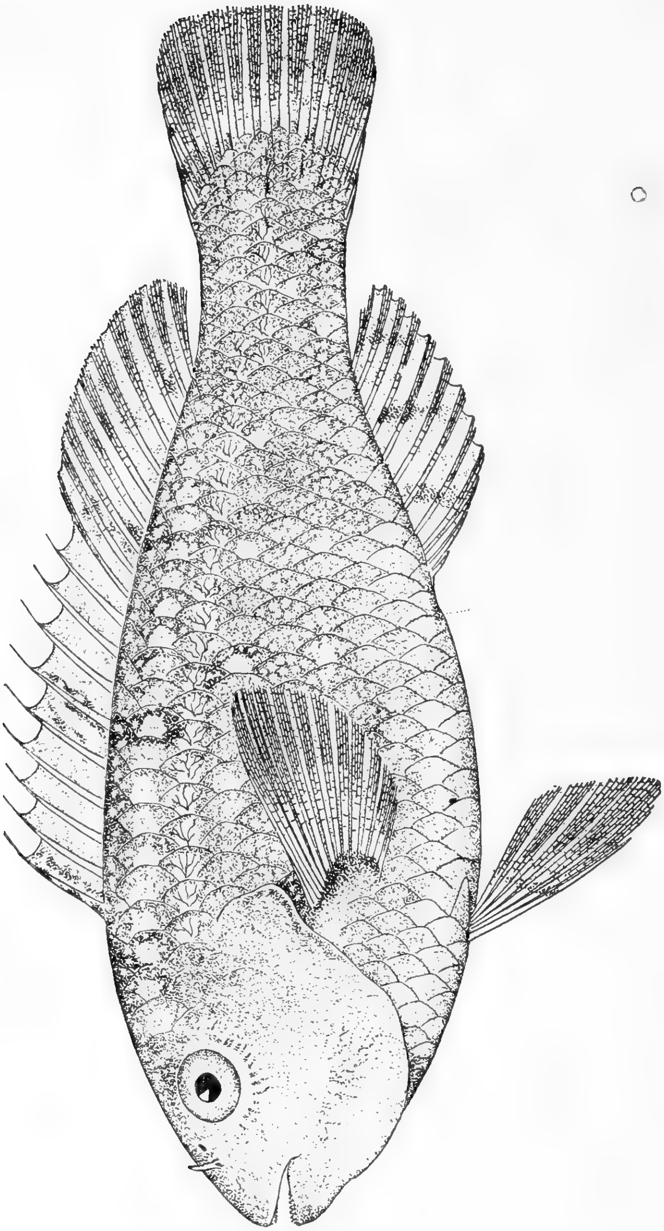
95b. SPARISOMA DISTINCTUM.

Scarus distinctus Poey, Mem., ii, 423, 1860; Poey Repertorio, ii, 163; Poey, Syn., 341; Poey, Enum., 114 (Havana).
Scarus frondosus Günther, iv, 210 (Cuba; Jamaica; Trinidad; Brazil).

Habitat.—West Indian fauna.

Etymology: *Distinctus*, distinct.

A type of *Scarus distinctus* Poey is in the National Museum. It agrees with the species called in this paper *Sparisoma frondosum*, differing only in the presence of a posterior canine and in the more sharply defined coloration. It is probable that it belongs to the same species, but in view of the uncertainty, I here give *Sparisoma distinctum* place



SPARISOMA HOPLOMYSTAX Cope.

(No. 35173, U. S. N. M.; from Key West, Florida.)

as a doubtful species. If the canine is normally present in *S. frondosum*, its relations would be rather with *S. niphobles* than with *S. flavescens*.

96. SPARISOMA NIPHOBLES.

Sparisoma niphobles Jordan & Bollman, Proc. U. S. Nat. Mus., 1889 (Green Turtle Cay, Bahamas).

Habitat.—West Indian fauna.

Etymology: *Νίφοβλης*, snowed upon, from the white spots.

This species is known from a single specimen taken by Mr. Charles L. Edwards at Green Turtle Cay, in the Bahamas. From this specimen our description is taken.

The species is very close to *S. radians* and *S. hoplomystax*, but we can not identify it with either of these.

97. SPARISOMA HOPLOMYSTAX. (PLATE X.)

Labrus radians Castelnau, Anim. Nouv., etc., Amérique du Sud., 1855, 29 (Bahia), (not *Scarus radians* Cuv. & Val.).

Scarus radians Günther, iv, 211 (Jamaica; Bahia) (not of Cuv. & Val.); Jordan & Gilbert, Synopsis Fish N. A., 1883, 906 (copied).

Scarus hoplomystax Cope, Trans. Am. Philo. Soc., 1869, 462 (St. Martin's).

Sparisoma cyanolene Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 98 (Key West); Jordan, l. c., 137 (Key West); Bean, Bull. U. S. Fish Com., 1888, 198 (Cozumel).

Habitat.—Florida Keys and southward to Bahia.

Etymology: *Ὅπλον*, weapon; *μύσταξ*, upper jaw.

This little fish is very abundant about Key West, where many specimens were taken with the seine in the kelp. None of these were more than 6 inches in length, and as they were sexually mature at that size it is not likely that they grow much larger.

The prevalence of blue around the base of the pectoral is a striking color mark which does not soon disappear in alcohol.

Specimens were also obtained by the *Albatross* at St. Lucia and at Bahia. A careful comparison of our specimens with the description of *S. hoplomystax* seems to show that the characters of *S. cyanolene* are due to the fresh condition of the types of that species.

98. SPARISOMA RADIANS.

Scarus radians Cuv. & Val., xiv, 206, 1839; Guichenot, Scarides, 17, 1865 (note on types); ? Goode, Bull. U. S. Nat. Mus., v, 1876, 32 (Bermudas).

? *Sparisoma radians* Bean & Dresel, Proc. U. S. Nat. Mus., 1884, 153 (Jamaica).

Scarus lacrimosus Poey, Mem., ii, 422, 1860; Poey, Syn., 343, 1868; Poey, Enumeratio, 113, 1875 (Havana).

? *Scarus atomarius* Poey, Mem., ii, 423, 1861; Poey, Syn., 343, 1868; Poey, Enumeratio, 115, 1875 (Havana).

Habitat.—West Indian fauna, Havana to Brazil.

Etymology: *Radians*, radiating.

Of this species we have examined three specimens taken by the *Albatross* at Bahia, the original locality of *S. radians*. These agree so well

with *S. lacrimosum* that we regard the latter species as identical, and we know of no character by which to separate *S. atomarium.*

A specimen sent by Poey to Cambridge seems to belong to *S. radians.* Color, in spirits, mottled brown, the caudal similarly mottled and faintly barred; no dark axillary spot; head plain; dorsal mottled. Caudal short, truncate, tubes of lateral line little branched; body rather elongate, the depth 3½ in length; pectoral short; two strong posterior canines, before which are several smaller pointed teeth. Another specimen has four pointed teeth on each side of upper jaw. This may represent *Sparisoma atomarium.*

Goode describes the life colors of the fish called by him *S. radians* as follows:

Above olive tinged with reddish brown, beneath rose-color; head, upper part of body, and dorsal marbled with brown; caudal irregularly banded with black, the extremity and spots on the membrane white; anal immaculate; base of pectorals black; chin white.

This is perhaps *Sparisoma xystrodon*, and doubtless *hoplomystax*, *radians*, and *xystrodon* have been confounded by authors under the name *radians.*

99. SPARISOMA XYSTRODON.

Sparisoma xystrodon Jordan & Swain, & Proc. U. S. Nat. Mus., 1884, 99 (Key West; Havana); Jordan, l. c., 137 (Key West); Bean, Bull. U. S. Fish. Com., 1888, 198 (Cozumel).

Habitat.—West Indian fauna, Florida Keys; Cuba, St. Lucia.

Etymology: ξύστρον, a scraper; ὀδούς, tooth.

This species is found in the eel-grass and Fucus about Key West, in company with *S. hoplomystax*, and is equally abundant with the latter. It reaches a still smaller size, none of the many specimens obtained exceeding 5 inches in length. These are sexually mature.

One or two specimens of this species were seen in the market at Havana, and many specimens were obtained by the *Albatross* at St. Lucia.

Genus XXIX.—SCARUS.

Callyodon Gronow, Museum Ichthyol., ii, 8, 1764 (non-binomial) (*croicensis*).

Scarus Forskål, Descr. Animal, etc., in Orient. Observ. 1775, 25 (*psittacus*, etc.), (not of Gronow, 1764, which (non-binomial) = *Labrus L.*).

Calliodon Bloch & Schneider, Syst. Ichthyol., 1801, 312 (*lineatus* = *croicensis*).

Hemistoma Swainson, Class'n, Fishes, etc., 1839, ii, 226 (*reticulatus* Sw. = *pepo* Bennett).

Petronason Swainson, Class'n, Fishes, etc., 1839, ii, 226 (*psittacus*, etc.).

Erychthys Swainson, Class'n, Fishes, etc., 1839, ii, 226 (*croicensis*, etc.).

Chlorurus Swainson, Class'n, Fishes, etc., 1839, ii, 227 (*gibbus*).

Callyodon Gronow, Systema, Ed. Gray, 1854, 83 (*lineatus*, etc.).

Pseudoscarus Bleeker, Versl. Akad. Wet. Amsterd., xii, 1861, Scaroid, 3 (*chlorodon*, *psittacus*, etc.).

Pseudoscarus Günther, Poey, Guichenot et Auct.

Scarus Jordan & Gilbert, Syn. Fish N. A., 1883, 938 (*psittacus*, *guacamaia*).

Calliodon Jordan, Proc. U. S. Nat. Mus., 1886, 591 (*croicensis*).

TYPE: *Scarus psittacus* Forskål.

Etymology: Σκάρος, Scarus, ancient name of *Sparisoma cretense*, said by Rondelet to be from σκαίρων, to pasture.

The name *Scarus* was used by the ancients and by some pre-Linnæan writers on zoology for the Mediterranean species of *Sparisoma*, *Labrus cretensis* L. By Gronow, a non-binomial writer, it was used in 1764 for a group substantially identical with the modern genus *Labrus*.

Its first use as a generic name in binomial nomenclature is that of Forskål in 1775. The genus *Scarus* of Forskål was based on several species obtained by him on the coasts of Arabia. A few of these are not Scaroids. The others all belong to the group called *Pseudoscarus* by Bleeker. Forskål had apparently no acquaintance with the *Labrus cretensis*, and this species can not in any proper sense be taken as the type of his genus. One of the species mentioned by him should be so taken, and as all his *Scari* belong to the same group, it makes no special difference which one is selected. Jordan and Gilbert have regarded *Scarus psittacus* Forskål as the type. If, however, *Sparisoma cretense* be taken as the type of *Scarus*, the proper name for the present genus would be *Calliodon*, and several of the useless generic names of Swainson have priority over *Pseudoscarus*.

Lately, in accordance with the rules of the American Ornithologists' Union, I had adopted the non-binomial but post-Linnæan generic names of Gronow, among them that of *Calliodon*, for the present genus. It seems better, however, *not* to use these names of Gronow. I have, therefore, retained *Scarus* as the name of the present group.

The genus *Scarus* contains the majority of the species of the subfamily of *Scarinæ*. It is more widely distributed than the other genera; its species reach for the most part a larger size, and in general they are more brightly colored than the others.

ANALYSIS OF SPECIES OF SCARUS.

Common characters.—Lower pharyngeals spoon-shaped, ovate-oblong, transversely concave; teeth in each jaw fully coalescent, appearing as tessellations on the surface; jaws with distinct median suture; edges of jaw even; upper pharyngeals each with two rows of teeth; gill membranes scarcely united to the narrow isthmus, across which they form a broad fold; dorsal spines flexible, scarcely different from the soft rays; upper lip laterally double, the interior fold becoming very narrow or obsolete mesially; lower jaw included in the closed mouth; lateral line interrupted posteriorly, commencing again on the next series of scales below; tubes of lateral line scarcely branched; scales on cheek in two to four rows; scales in front of dorsal on median line 6 to 8. Species mostly of large size, found in all tropical seas.

a. Teeth whitish.
  b. Upper jaw with from one to four posterior canines.
    c. Cheeks with from two to three rows of scales.
      d. Head with a longitudinal band; a yellow longitudinal stripe on body; outer rays of caudal not colored like the inner; caudal subtruncate.
        e. Outer rays of caudal blackish or greenish, darker than the median rays.
          f. Yellow stripe above pectoral about on a level with the eye; outer rays of caudal deep greenish blue; upper jaw with one

posterior canine (rarely duplicated); two and one-half rows of scales on cheeks; head with two bluish-green stripes, the interspace reddish or yellow; dorsal and anal each with two green bands and one orange one, the anal having a roundish blue spot on the membrane between every two rays. General color bluish-green mixed with orange. PUNCTULATUS, 100.

ff. Yellow stripe above pectoral, mostly below the level of the eye; outer rays of caudal blackish, the rest of the caudal green; upper jaw with two posterior canines; two rows of scales on cheeks; upper part of head dark green, below eye bright yellowish-green, with bluish markings on opercle; dorsal bright green at base; ventrals pale; base of pectoral with a blue-black mark. General color in life, bright green; darker on the back, paler below .... BOLLMANI, 101.

ee. Outer rays of caudal orange, lighter than the median rays, its edge blackish; yellow stripe above pectoral, below the level of the green stripes on the head, which are nearly horizontal; upper jaw with one posterior canine (rarely duplicated); two and one-half rows of scales on cheeks; head with two bluish-green stripes, the interspaces reddish or yellow; dorsal and anal each with two green bands and one orange one, the latter without blue spots; basal band of dorsal not broken into green spots. General color bluish green, mixed with orange .... TÆNIOPTERUS, 102.

dd. Head without longitudinal bands; posterior canines 2 to 4.

g. [Caudal truncate; two series of scales on cheeks, and two scales on lower preopercular limb; canines 2 or 3 on each side. Color, uniform violet-purple; vertical fins very dark.] (*Günther*.) .... ARACANGA, 103.

gg. Caudal fin lunate, the outer rays more or less produced; cheeks with 2½ or 3 rows of scales; posterior canines 3 or 4; color (dried skin) plain brownish, the caudal in one specimen (*quadrispinosus*) darker, in the other (*trispinosus*) paler mesially, its border and angles dark.

TRISPINOSUS, 104.

cc. Cheeks with four rows of scales; angles of caudal more or less salient.

h. [Sides with a broad whitish band; fins, plain reddish; caudal square, with salient points; snout rather pointed; upper lip deep blue, lower carmine; general color, violaceous; head olivaceous above, rosy below.] (*Poey*.) .... ACUTUS, 105.

hh. Sides without pale band; jaws nearly plain; color dusky olivaceous, some scales with a rosy blotch at base; dorsal edged with dusky; caudal dark, pale at base, and with pale shades, its angles little produced; opercle with blue blotches; canines 3; four rows of scales on cheek; snout rather acute; seven scales before dorsal .... CUZAMILÆ, 105*b*.

hhh. Sides without distinct pale band; jaws with bright colors; fins chiefly blue, darker on pectoral and front of caudal; middle of dorsal reddish, with blue spots; a red band near the edge of the caudal, one on the base of the anal and one near the upper edge of the

pectorals; ventrals mostly red, their external border blue; caudal with very salient angles; upper jaw with red and blue edgings; snout moderate; 2 (rarely 3) lateral canines in upper jaw. General color, dark sky-blue; scales, brown-edged; eye with blue spots above and behind; a green band from the angle of the mouth, bordered above and below by red. Teeth quite small.................VETULA, 106.

bb. Upper jaw without canines; two and one-half series of scales on cheek.

i. Third (partial) row of scales of the cheek of 3 or 4 scales* of the upper row little larger than those of the second row.* Caudal slightly rounded, its outer rays not produced.

j. Sides of body with two broad dark longitudinal shades; sides of belly each with three sharply defined lines, each on a row of scales, these stripes running from the breast to beyond front of ventrals (these lines usually becoming faint or even obsolete in old specimens).

k. Stripes on side of breast, if present, whitish. Color, dark reddish brown above, paler below; back dark; sides with two dark parallel stripes of the color of the back, separated by paler interspaces, the upper one extending backward from eye; snout above bluish brown; a narrow whitish streak running from head along the middle line of belly; a faint dark spot on base of pectoral; caudal pale orange-red, the outer rays somewhat barred with brown; dorsal orange, edged with bluish; other fins nearly plain.

CROICENSIS, 107.

kk. Stripes on side of breast, if present, inky blue. Color bright green, olivaceous above, paler below, the lower half of the body becoming posteriorly more and more yellow, and on the lower half of the caudal peduncle bright light yellow, this color being brightest above front of anal; longitudinal shades on sides of body bright crimson, separated on the head by a band of green; no spot on base of pectoral; caudal fin green, its lower half yellow; dorsal, anal, and pectorals green, at least at base; ventrals yellow.

EVERMANNI, 108.

jj. [Sides of body without distinct, broad, darker stripes. Color, brown; no bands or lines upon body or head; dorsal spotted with violet and edged above and below with yellow, like the caudal; caudal without spots; a yellow line near the edge, and another along the base of the dorsal.] (*Guichenot.*)

FLAVOMARGINATUS, 109.

ii. Third (partial) row of scales on the cheek of 1 or 2 scales only; scales of the upper row much larger than those of the second row; caudal subtruncate, its outer rays more or less produced, becoming much elongate with age; adult with a fleshy hump above the snout. Color bright blue, the young more or less shaded with reddish brown; fins mostly blue. Size large.

CŒRULEUS, 110.

* These two characters not verified in *S. flavomarginatus.*

aa. Teeth blue or bluish-green.

l. Upper jaw with canines; caudal fin with angles much exserted, especially in the adult: soft dorsal and anal ending in points; two and one-half rows of scales on cheeks.

m. Upper jaw usually with 1 posterior canine. Color bright blue, the edges of the scales brownish; fins dark brown, with green upon the external border of the ventrals, which are long and pointed; forehead with a fleshy hump in the adult.

n. Tubes of the lateral line considerably branched. CŒLESTINUS, 111.

nn. Tubes of the lateral line not branched .. SIMPLEX, 112.

mm. [Upper jaw with from 3 to 6 posterior canines; jaws very convex. Color green under pectoral, and along the side and posterior part of the body; head, anterior and upper part of the back and belly grayish yellow; dorsal and anal brown, spotted with green along their bases; pectorals and ventrals tinted with green; caudal grayish yellow. Size large.] (*Guichenot*) .... PLEIANUS, 113.

ll. Upper jaw without posterior canines; teeth deep blue-green. Size large.

o. Caudal deeply notched, the angles much produced in the adult (the fin truncate or rounded in the young); body moderately elongate; depth $2\frac{1}{2}$ to 3 in length; cheeks with $2\frac{1}{2}$ rows of scales, those of the upper row larger than those of the second; one scale below the second row. Color olive green, with more or less ill-defined green markings on head; lower parts more or less reddish; vertical fins brownish orange, all edged with deep blue .... GUACAMAIA, 114.

oo. Caudal rounded, the angles not produced; body robust, the depth in adult $2\frac{1}{5}$ in length; cheeks with two rows of scales, the lower of four, the upper of five scales; lower limb of preopercle wholly naked. Color light brownish, with some greenish shading on sides and bluish green on caudal peduncle; fins all bright blue; snout and forehead bluish; orbits surrounded by radiating dots and dashes of green. PERRICO, 115.

100. SCARUS PUNCTULATUS.

Scarus punctulatus Cuv. & Val., xiv, 1839, 195 (Martinique); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 80 (Havana).

Pseudoscarus punctulatus Guichenot, Scaridés, Mus. Paris, 1865, 26 (Martinique).

Scarus diadema Cuv. & Val., 14, 1839 (Martinique); Cope, Trans. Am. Phil. Soc., 1871, 461 (St. Martin; St. Croix).

Pseudoscarus diadema Poey, Synopsis, 347; Poey, Enumeratio, 116; Guichenot, Scaridés, 28, 1865 (note on types).

Pseudoscarus tæniopterus Günther, iv, 226 (Trinidad; excellent description; not of Desmarest).

Scarus tæniopterus Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).

Habitat.—West Indies.

Etymology: *Punctulatus*, dotted.

This species is one of the most brilliant of the group, and may be known by the coloration of the anal fin, which has suggested the name *punctulatus*.

Our single specimen is from Havana. Another from Porto Rico is in the museum at Cambridge. The *Scarus diadema* seems to be the same, but of this we are not quite certain.

101. SCARUS BOLLMANI.

Scarus bollmani Jordan & Evermann, Proc. U. S. Nat. Mus., 1886, 470 (off Tampa Bay).

Habitat.—Gulf of Mexico in deep water.

Etymology: Named for its discoverer, Charles Harvey Bollman.

This species is known from the original types only, taken from the stomachs of groupers (*Epinephelus*) by Mr. Charles H. Bollman.

102. SCARUS TÆNIOPTERUS.

Scarus tæniopterus Desmarest, Dict. Classique, xv, 244, pl. 12, 1831 (Cuba); Cuv. & Val., xiv, 195 (same type); Jordan, Proc. U. S. Nat. Mus., 1886, 543 (note on original type).

Pseudoscarus tæniopterus Guichenot, Scaridés Mus. Paris, 1865, 26 (same specimen).

Scarus vetula Cuv. & Val., xiv, 193, 1839 (St. Thomas; not of Bloch & Schneider, based on a figure of Parra).

Pseudoscarus psittacus Günther, iv, 225, 1862 (Cuba; Jamaica; after *Coryphæna psittacus* L., which is a species of *Xyrichthys;* not *Scarus psittacus* Forskål, an Asiatic species); Guichenot, Scaridés, Mus. Paris, 1865, 25 (Martinique; St. Lucia); Poey, Synopsis, 347 (Cuba); Poey, Enumeratio, 116.

Scarus psittacus Cope, Trans. Am. Philos. Soc., 1871, 461 (St. Martin; St. Croix).

Scarus virginalis Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 88 (Havana); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana).

Habitat.—West Indies.

Etymology: *Ταινία*, ribbon; *πτερόν*, fin.

Our specimens of this species are from Havana, and St. Thomas. Others are in the museum at Cambridge from Porto Rico and St. Thomas. The types of *Scarus tæniopterus* examined by us in Paris belong to the species called by Jordan & Swain *Scarus virginalis*. The latter name should therefore be suppressed.

The name *psittacus* has been used by recent writers for this species. The original type of *Coryphæna psittacus*, sent by Dr. Garden from Charleston, is still preserved by the Linnæan Society of London. It has been examined by Dr. Bean, who has found it to be a *Xyrichthys*.

There seems to be also no doubt that the original *Vieja* (pl. 28, f. 1), of Parra, on which the *Scarus vetula* of Bloch & Schneider is based, is identical with the *Scarus superbus* of Poey, rather than with the present species, to which it has been referred by Cuvier & Valenciennes. The name *vetula* must therefore supersede *superbus*, as already noticed by Mr. Goode (Bull. U. S. Nat. Mus., v, 32.).

103. SCARUS ARACANGA.

Pseudoscarus aracanga Günther, iv, 227, 1862 (Jamaica).

Habitat.—West Indian fauna.

Etymology: Portuguese name for some parrot.

This doubtful species is unknown to us. According to Dr. Günther "it has exactly the same coloration (as *Sparisoma aracanga*), with which it may be easily confounded."

104. SCARUS TRISPINOSUS.

Scarus trispinosus Cuv. & Val., xiv, 182, 1839 (Brazil).
Pseudoscarus trispinosus Guichenot, Scaridés, 23, 1865 (note on type).
Scarus quadrispinosus Cuv. & Val., xiv, 197, 1839 (Martinique); Guichenot, Scaridés, 27, 1865 (note on type); Jordan, Proc. U. S. Nat. Mus., 1886, 542 (note on type).
Pseudoscarus quadrispinosus Goode, Bull. U. S. Nat. Mus., v, 34, 1876.
? *Pseudoscarus chloris* Günther, iv, 227, 1862 (not *Scarus chloris* Bloch & Schneider).

Habitat.—West Indian fauna.

Etymology: *Trispinosus*, three-spined.

We know this species only from the dried skin which formed the original type of *Scarus quadrispinosus*. It is probably not distinct from *Scarus trispinosus*, likewise based on a dried skin, which, however, we have not examined.

105. SCARUS ACUTUS.

Scarus acutus Poey, Mem., ii, 216, 1861 (Havana).
Pseudoscarus acutus Poey, Syn., 350, 1868; Poey, Enumeratio, 118, 1875 (Havana).
Scarus gnathodus Poey, Repert., ii, 240, 1860 (Havana).
Pseudoscarus gnathodus Poey, Syn., 350, 1868; Poey, Enumeratio, 119, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Acutus*, sharp-pointed.

We know this species from Poey's descriptions only. There seems to be little doubt that *gnathodus* is identical with *acutus*.

105*b*. SCARUS CUZAMILÆ. (PLATE VII, FIG. 3.)

Scarus cuzamilæ Bean, Bull. U. S. Fish Com., 1888, 196 (Cozumel).

Habitat.—West Indian fauna.

Etymology: "In allusion to the ancient name of the island" of Cozumel.

This species, apparently nearly allied to *S. acutus*, is known from one specimen about a foot long, taken at Cozumel, by Dr. Bean.

106. SCARUS VETULA.

(MUD-FISH; VIEJA.)

Vieja Parra, Dief. Piezas, etc., 1787, 58, lam. 28, f. 1 (Havana).
Scarus vetula Bloch & Schneider, Ichthyol., 289, 1801 (after Parra); Cuv. & Val., xiv, 193, 1839 (St. Thomas); Guichenot, Scarides, 25, 1865 (note on type); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 90.
Pseudoscarus vetula Goode, Bull. U. S. Nat. Mus., v, 1876, 32 (Bermuda).
Scarus superbus Poey, Mem., ii, 218, 1861.
Pseudoscarus superbus Günther, iv, 218, 1862; Poey, Synopsis, 346, 1868; Poey, Enumeratio, 116, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Vetula*, old woman, given in allusion to the Spanish name *Vieja;* English name, *Old Wife.*

This species is one of the most gorgeous of the parrot fishes, reaching a length of nearly two feet. The specimens examined by us were sent by Professor Poey to the museum at Cambridge.

107. SCARUS CROICENCIS.

(BULLON.)

Callyodon Gronow, Museum Ichthyol., ii, 8, 1763; Gronow, Zoöphylaceum, 244, t. 7, f. 4 (*sine patria*).

Scarus croicensis Bloch, Ichthyol., taf. 221, 1790 (St. Croix; probably more than one species included); Jordan & Gilbert, Syn. Fish. N. A., 1883, 938 (copied); Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 87 (Havana; Key West); Jordan, l. c., 137 (Key West); Jordan, Proc. U. S. Nat. Mus., 1886, 47 (Havana); Bean, Bull. U. S. Fish Com., 1888, 198 (Cozumel).

Erychthys croicensis Swainson, Nat. Hist. Class'n, Fishes, 1839, ii, 226 (name only).

Scarus insulæ-sanctæ-crucis Bloch & Schneider, Syst. Ichthyol., 1801, 285 (copied).

?*Calliodon lineatus* Bloch & Schneider, Syst. Ichthyol., 1801, 312, pl. 62, f. 2 (after Gronow); Gronow, Syst., ed. Gray, 1854, 84 (*sine patria*).

Scarus alternans Cuv. & Val., iv, 1839, 200 (Martinique).

Pseudoscarus sanctæ-crucis Günther, iv, 226, 1862 (Jamaica; Trinidad; Puerto Cabello); Guichenot, Scaridés, Mus. Paris, 1865, 29 (Martinique); Poey, Synopsis, 1868, 350 (Cuba); Poey, Enumeratio, 1875, 119.

Scarus sanctæ-crucis Cope, Trans. Am. Philos. Soc., 1870, 461 (St. Croix).

Pseudoscarus lineolatus Poey, Repertorio, ii, 239, 1868 (Cuba); Poey, Synopsis, 350; Poey, Enumeratio, 1875, 119.

Habitat.—West Indian fauna, north to Key West.

Etymology: *Croicensis*, living in St. Croix, where the species was discovered.

Several young specimens of this species were taken at Key West by Dr. Jordan. In Havana it is rather common, and is known as *Bullon*. Specimens are in the museum at Cambridge from Bermuda, Tortugas, St. Thomas, and St. Croix.

It seems never to reach a large size. Goode has suggested that it is perhaps the young of *Scarus vetula* (=*superbus* Poey), but we are very positive that this can not be the case. The two are very unlike in dentition, as well as in color.

There is no warrant for the change of the original name *croicensis* into *sanctæ-crucis*, and we have as a matter of course restored the original form of the word.

The *Calliodon lineatus* seems to us, as suggested by Valenciennes, to be probably this species.

Poey recognizes *Pseudoscarus lineolatus* with the three streaks along the side of the breast, and *P. sanctæ-crucis*, in which these markings are obsolete. These stripes are present in all our specimens from Cuba and Florida, but in a larger example from St. Lucia they are very faint or obsolete. Their absence is probably a matter of age, not of specific difference.

108. SCARUS EVERMANNI.

Scarus evermanni Jordan, Proc. U. S. Nat. Mus., 1886, 469 (off Tampa Bay).

Habitat.—Gulf of Mexico in deep water.

Etymology: Named for Barton Warren Evermann.

Only the original type of this handsome species is known. It was taken from the stomach of some large fish off the west coast of Florida by Mr. Charles H. Bollman. Its resemblance to *Sc. croicensis* is quite strong, but the coloration is notably different.

109. SCARUS FLAVO-MARGINATUS.

Scarus flavo-marginatus Cuv. & Val., xiv, 202, 1839 (Antilles).
Pseudoscarus flavo-marginatus Guichenot, Scaridès, 30, 1865 (note on type).

Habitat.—West Indies.

Etymology: *Flavus*, yellow; *marginatus*, margined.

We know nothing of this species except what is contained in the scanty descriptions of Valenciennes and Guichenot.

110. SCARUS CŒRULEUS.

(BLUE PARROT FISH; LORO; CLAMAGORE.)

Novacula cærulea (the *Bluefish*) Catesby, Nat. Hist. Carolina, etc., 1743, 18, tab. 18 (Bahamas).
Loro Parra, Descr. Dif. Piezas Hist. Nat., 1787, 57, Lam. 27, f. 1. (Cuba).
Trompa Parra, l. c., f. 2.
Coryphæna cærulea Bloch, Ausländische Fische, ii, 120, taf. 176, 1786 (in part, after Catesby and a figure of Aubriet, altered from a figure by Plumier); Gmelin, Syst. Nat., 1788, 1191 (copied).
Scarus cæruleus Bloch & Schneider, Systema Ichthyol., 1801, 288 (after Catesby, and Trompa of Parra); Cuv. & Val., xiv, 186, 1839 (St. Thomas); Cuvier, Règne Animal, Ed. ii, 1829; Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 85 (Havana; Key West); Jordan, Proc. U. S. Nat. Mus., 1884, 137 (Key West); Jordan, l. c., 1886, 48 (Havana).
Pseudoscarus cæruleus Günther, iv, 1862, 227 (copied); Guichenot, Scaridés, Mus. Paris (Proc. Soc. Imp. Nat. Cherbourg), 1865, 24 (St. Thomas, San Domingo); Poey, Repertorio, i, 373, 1867; Poey, Synopsis, 1868, 348; Poey, Enumeratio, 1875, 117 (Cuba); Goode, Bull. U. S. Nat. Mus., v, 33, 1876 (Bermuda).
Scarus loro Bloch & Schneider, Systema Ichthyol., 1801, 288 (after *Loro* of Parra).
? *Scarus trilobatus* Lacépède, Hist. Nat. Poiss., iv, 1803, 21 (on a drawing by Plumier).
? *Scarus holocyaneos* Lacépède, Hist. Nat. Poiss., iv, 1803, 45, on a copy by Aubriet of a drawing of Plumier; the copy colored entirely blue in order to represent this species; the original drawing probably intended for *Sparisoma chrysopterum*; the same copy by Aubriet, the original of Bloch's engraving of *Scarus cæruleus*.
Scarus obtusus Poey, Memorias Cuba, ii, 1860, 217 (Cuba).
Pseudoscarus obtusus Poey, Synopsis, 349; Poey, Enumeratio, 117.
Scarus nuchalis Poey, Memorias, ii, 1860, 220 (Cuba).
Pseudoscarus nuchalis Poey, Synopsis, 348; Poey, Enumeratio, 117.
Pseudoscarus chloris Günther, iv, 1862, 227 (Jamaica; Excl. Syn.).
Pseudoscarus quadrispinosus Goode, Bull. U. S. Nat. Mus., v., 34 (not *Scarus quadrispinosus* Cuv. & Val. ?).

Habitat.—West Indies, north to Key West.

Etymology: *Cæruleus*, blue.

This species is common in the Havana markets. A single young specimen was taken at Key West. Specimens from St. Thomas are in the museum at Cambridge.

No specimens of more than a foot in length were obtained by me, and these show but slight traces of the fleshy hump on the snout, which is said to be very conspicuous in the adult fish. They correspond fairly

to the *Loro* of Parra and to the *Scarus obtusus* of Poey. It is possible that these specimens are not the young of the large-humped *cæruleus*, but as no differences other than in the development of the hump and of the lobes of the caudal are to be found we refer them without much hesitation to *S. cæruleus*. The same opinion is expressed by Günther, who considers his *chloris* as probably the young of *cæruleus*. His *chloris* is evidently our fish, though not the *chloris* of Bloch.

There is some confusion in regard to the original *Coryphæna cærulea* of Bloch, which must be regarded as in part only based on this species. The *Scarus cæruleus* of Bloch & Schneider is, however, free from any confusion with *chrysopterum* or related species. *Scarus trilobatus* Lacépède is somewhat doubtful, and *Sparus holocyaneos* Lac. is involved in confusion with *Sparisoma chrysopterum*. The *obtusus* and *nuchalis* of Poey are probably forms of *cæruleus*.

111. SCARUS CŒLESTINUS.

Scarus cælestinus Cuv. & Val., xiv, 180, 1839 (St. Thomas); Jordan, Proc. U. S. Nat. Mus., 1886, 543 (St. Thomas), (note on original type).

Pseudoscarus cælestinus Guichenot, Scaridés, 22, 1865 (note on type); Poey, Syn., 349, 1868; Poey, Enumeratio, 118, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Cœlestinus*, heavenly (blue).

This species is known to us only from the examination of the original type, a dried skin in the museum at Paris. It is apparently distinct both from *Sc. cæruleus* and *Sc. guacamaia*.

112. SCARUS SIMPLEX.

Pseudoscarus simplex Poey, Repert., i, 185, 1867; Poey, Syn., 349, 1868; Poey, Enumeratio, 118, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Simplex*, simple.

We know this species from Poey's description only. It is very close to *Sc. cœlestinus*, and may not be different from the latter.

113. SCARUS PLEIANUS.

Scarus guacamaia Cuv. & Val., xiv, 178, 1839 (St. Thomas).

Pseudoscarus guacamaia Guichenot, Scaridés, 21, 1865 (note on type), (not *Scarus guacamaia* Cuvier).

Scarus pleianus Poey, Mem. Cub., ii, 393, 1860 (based on *Sc. guacamaia* C. & V.).

Habitat.—West Indies.

Etymology: Named for M. Plée, who collected for Cuvier in the West Indies.

It is evident that *Scarus guacamaia* C. & V., the "Grand Scare aux machoires bleus," with 3 to 6 posterior canines, can not be the original *Scarus guacamaia* of Cuvier, which has no canines at all. No other writer (except Guichenot) has examined any specimens referable to the *guacamaia* of Valenciennes, but Poey has given to these descriptions the name of *Scarus pleianus*, which species must keep if it be really valid.

114. SCARUS GUACAMAIA. (PLATE XI.)

(GUACAMAIA; PARROT-FISH.)

Guacamaia Parra, Descr. Dif. Piezas Hist. Nat., 1787, p. 54, pl. 26 (Cuba).

Scarus guacamaia Cuvier, Règne Animal, Ed. ii, 1829, 265. (No description; based on Parra. Not *Scarus guacamaia* Cuv. & Val. = *Scarus pleianus* Poey.) Jordan & Gilbert, Syn. Fish. N. A., 1883, 938; Bean, Bull. U. S. Fish. Com., 1888, 198 (Cozumel).

Pseudoscarus guacamaia Günther, iv, 233 (Jamaica; Puerto Cabello; Bahia); Poey, Synopsis, Pisc. Cubens., 1868, 348, 463; Poey, Enumeratio, Pisc. Cubens., 1875, 177.

Hemistoma guacamaia Jordan & Gilbert, Syn. Fish. N. A., 1883, 607 (Key West).

Scarus guacamaia Jordan & Swain, Proc. U. S. Nat. Mus., 1884, 84 (Havana; Key West); Jordan, l. c., 137 (Key West); Jordan, Proc. U. S. Nat. Mus., 1886, 48 (Havana).

Scarus turchesius Cuv. & Val., xiv, 181, 1839 (Porto Rico); Guichenot, Scaridés, 23, 1865 (note on type); Jordan, Proc. U. S. Nat. Mus., 1886, 543 (note on original type).

Pseudoscarus turchesius Poey, Repert., i, 317, 1861; Poey, Syn., 348, 1868; Poey, Enumeratio, 118, 1875 (Havana); Poey, Fauna Puerto Riqueña, 337, 1895 (Havana).

Scarus rostratus Poey, Mem., ii, 221, 1867; Poey, Repert., 163, 1867 (Havana).

Pseudoscarus rostratus Poey, Syn., 349, 1868; Poey, Enumeratio, 118, 1875 (Havana).

Habitat.—West Indies.

Etymology: *Guacamaia*, a Spanish word for parrot.

This species is abundant about rocks at Key West, and is also not uncommon in the Havana market, where it is known still as *Guacamaia*. Our fish appears to be the *Guacamaia* of Parra, on which, so far as the printed record shows, the *Scarus guacamaia* of Cuvier was based. The specimens in Cuvier's possession, afterwards described by Valenciennes under the name of *Scarus guacamaia*, have canines in the upper jaw, and apparently belong to a distinct and (to us) unknown species, to which Poey has given the name *Scarus pleianus*. We have seen no specimens a yard in length, as mentioned by Parra, nor have we seen any with the caudal lobes prolonged to the extent shown in his figures.

None of our specimens, young or old, show traces of canines.

We have examined the type of *Scarus turchesius* in Paris. It seems to be the same as our *guacamaia*. Poey's *Scarus rostratus* seems to be based on young examples with rather sharper snout than usual.

A specimen of *Sc. guacamaia* from Rio Janeiro is in the museum at Cambridge. Another was taken by the *Albatross* at Bahia.

115. SCARUS PERRICO.

(PERRICO; LORO.)

Scarus perrico Jordan & Gilbert, Proc. U. S. Nat. Mus., 1881, 357 (Mazatlan).

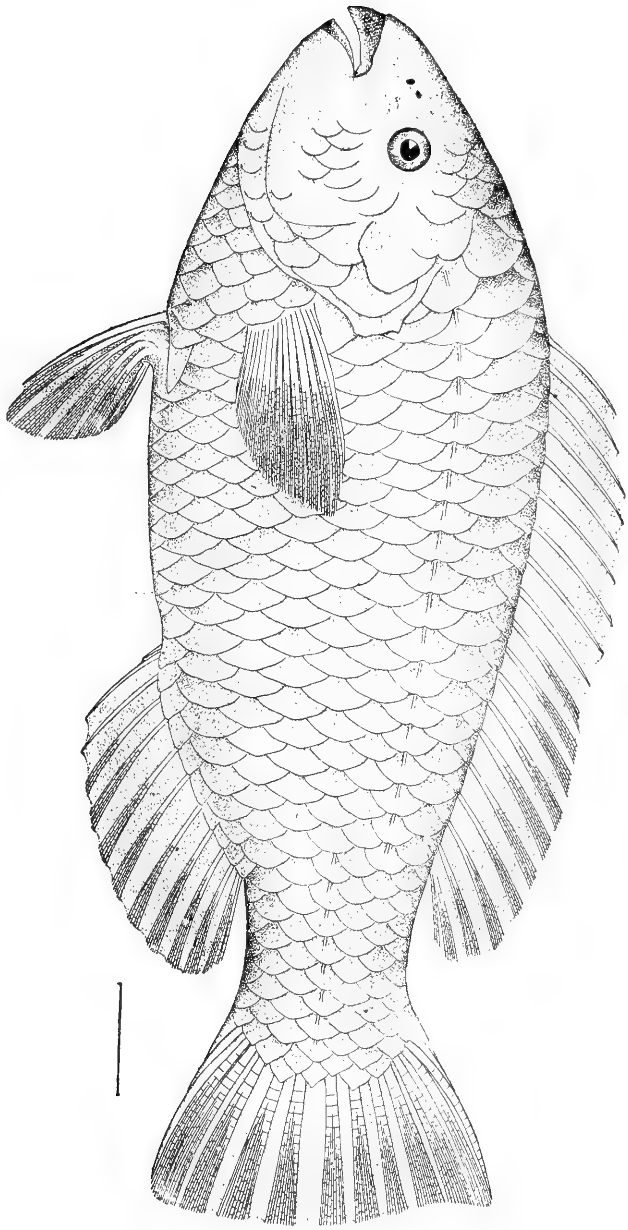
Habitat.—Pacific coast of tropical America.

Etymology: *Perrico*, a Spanish word for parrot.

This large species is very common in the rocks about Mazatlan. It is seldom caught, and is not eaten. The type in the U. S. National Museum (No. 28328) is 23 inches in length.

It is remarkable that this single species and *Calotomus xenodon* are the only Scaroid fishes yet described from the eastern Pacific.

PLATE XI.



SCARUS GUACAMAIA Cuvier. Guacamaia; Parrot-fish.
(No. 5850, U. S. N. M.; from Garden Key, Florida.)

RECAPITULATION.

The following is the list of Labridæ recognized by us as occurring in the waters of America and Europe. The distribution, in general, of each species is indicated by the use of the following letters:

E. Europe.
I. Islands of eastern Atlantic.
N. North Atlantic coast, north of Cape Hatteras
S. South Atlantic and Gulf coast.
W. West Indies and Brazil.
C. Southern California.
P. Pacific coast of tropical America.
V. Pacific coast of South America.

Family LABRIDÆ.

Subfamily A.—LABRINÆ.

Genus 1.—**Centrolabrus** Günther.
1. *Centrolabrus exoletus* (Linnæus). E.
2. *Centrolabrus trutta* (Lowe). I.

Genus 2.—**Acantholabrus** Cuvier & Valenciennes.
3. *Acantholabrus palloni* (Risso). E., I.

Genus 3.—**Labrus** (Artedi) Linnæus.
4. *Labrus berggylta* Ascanius. E.
5. *Labrus comber* Gmelin. E. (Probably a variety of the preceding.)
6. *Labrus livens* Linnæus. E. (Perhaps to be called *Labrus merula.*)
7. *Labrus nubilus* Valenciennes. E., I. (Doubtful species.)
8. *Labrus viridis* Linnæus. E.
9. *Labrus bimaculatus* Linnæus. E.

Genus 4.—**Symphodus** Rafinesque.

§ *Crenilabrus* Cuvier.

10. *Symphodus mediterraneus* (Linnæus). E.
11. *Symphodus tinca* (Linnæus). E.
12. *Symphodus melops* (Linnæus). E.
13. *Symphodus melanocercus* (Risso). E.
14. *Symphodus cinereus* (Bonnaterre). E.
15. *Symphodus doderleini* Jordan. E.
16. *Symphodus pirca* (Walbaum). E. (Perhaps to be called *S. bailloni.*)
17. *Symphodus ocellaris* (Linnæus). E. (Possibly to be called *S. cæruleovittatus* or *S. unimaculatus.*)
18. *Symphodus ocellatus* (Forskål). E.

§ *Symphodus.*

19. *Symphodus scina* (Forskål). E.

Genus 5.—**Ctenolabrus** Cuv. & Val.

§ *Lappanella* Jordan.

20. *Ctenolabrus iris* Cuv. & Val. E.

§ *Ctenolabrus.*

21. *Ctenolabrus suillus* (Linnæus). E.

§ *Tautogolabrus* Günther.

22. *Ctenolabrus adspersus* (Walbaum). N.
23. *Ctenolabrus brandaonis* (Steindachner). B.

Genus 6.—**Hiatula** Lacépède.

24. *Hiatula onitis* (Linnæus). N.

Subfamily B.—HARPINÆ.

Genus 7.—**Lachnolaimus** Cuvier.

25. *Lachnolaimus maximus* (Walbaum). W., S.

Genus 8.—**Harpe** Lacépède.

26. *Harpe diplotænia* Gill. P.
27. *Harpe rufa* (Linnæus). W., B.
28. *Harpe eclancheri* (Valenciennes). V.
29. *Harpe tridecemspinosa* (Günther). (Doubtful species; perhaps to be called *H. jagonensis*.)
30. *Harpe pulchella* Poey. W.

Genus 9.—**Lepidaplois** Gill.

31. *Lepidaplois scrofa* (Cuv. & Val.). I.

Genus 10.—**Decodon** Günther.

32. *Decodon puellaris* (Poey). W.

Genus 11.—**Trochocopus** Günther.

§ *Trochocopus.*

33. *Trochocopus maculatus* (Perez). V.

§ *Pimelometopon* Gill.

34. *Trochocopus pulcher* (Ayres). C.
35. *Trochocopus darwini* (Jenyns). V.

Genus 12.—**Graus** Philippi.

36. *Graus nigra* Philippi. V.

Subfamily C.—CLEPTICINÆ.

Genus 13.—**Clepticus** Cuv. & Val.

37. *Clepticus genizara* (Bloch & Schneider). W.

Subfamily D.—JULIDINÆ.

Genus 14.—**Pseudolabrus** Bleeker.

§ *Pseudolabrus.*

38. *Pseudolabrus gayi* (Cuv. & Val.). V.

Genus 15.—**Julis** Cuvier. (Perhaps a subgenus under *Coris*.)

39. *Julis julis* (Linnæus). E.

Genus 16.—**Leptojulis** Bleeker.

40. *Leptojulis bimaculatus* Kner & Steindachner. V.

Genus 17.—**Halichœres** Rüppell.

§ *Ichthycallus* Swainson.

41. *Halichœres radiatus* (Linnæus). W., S.
42. *Halichœres nicholsi* (Jordan & Gilbert). P.
43. *Halichœres sellifer* Gilbert. P.
44. *Halichœres semicinctus* (Ayres). C.
45. *Halichœres garnoti* (Cuv. & Val.). W.

46. *Halichœres dimidiatus* (Agassiz). W., B.
47. *Halichœres maculipinna* (Muller & Troschel). W.
48. *Halichœres bivittatus* (Bloch). W., S.
49. *Halichœres dispilus* (Günther). P.
50. *Halichœres poeyi* (Steindachner). B. (Synonymy doubtful.)
51. *Halichœres caudalis* (Poey). W. (Synonymy doubtful.)

Genus 18.—**Pseudojulis** Bleeker.

§ ———.

52. *Pseudojulis adustus* Gilbert. P.
53. *Pseudojulis notospilus* Günther. P.
54. *Pseudojulis venustus* Jenkins & Evermann. P.

§ *Oxyjulis* Gill.

55. *Pseudojulis californicus* (Günther). O.

§ *Pseudojulis.*

56. *Pseudojulis inornatus* Gilbert. P.
57. *Pseudojulis melanotis* Gilbert. P.

Genus 19.—**Thalassoma** Swainson.

58. *Thalassoma lucasanum* (Gill). P.
59. *Thalassoma socorroense* Gilbert. P.
60. *Thalassoma nitidum* (Günther). W.
61. *Thalassoma pavo* (Linnæus). E., I.
62. *Thalassoma steindachneri* Jordan. P. (Perhaps a variety of *T. melanochir.*)
63. *Thalassoma bifasciatum* (Bloch). W.
64. *Thalassoma grammaticum* Gilbert. P.
65. *Thalassoma virens* Gilbert. P.

Genus 20.—**Doratonotus** Günther.

66. *Doratonotus megalepis* Günther. W., S.

Genus 21.—**Xyrula** Jordan.

67. *Xyrula jessiæ* Jordan. W.

Genus 22.—**Xyrichthys** Cuvier.

§ *Novaculichthys* Bleeker.

68. *Xyrichthys rosipes* Jordan & Gilbert. W.
69. *Xyrichthys splendens* Castelnau. B.
69 *b* *Xyrichthys ventralis* Bean. W. (Perhaps identical with *X. rosipes.*)
70. *Xyrichthys martinicensis* Cuv. & Val. W., B.
70 *b* *Xyrichthys infirmus* Bean. W.

§ *Xyrichthys.*

71. *Xyrichthys uniocellatus* Agassiz. B.
72. *Xyrichthys mundiceps* Gill. P.
73. *Xyrichthys novacula* (Linnæus). S., W., E. (Perhaps includes two or three species, *X. novacula*, *psittacus*, and *vermiculatus.*)
74. *Xyrichthys modestus* Poey. W. (Doubtful species.)

Genus 23.—**Iniistius** Gill.

75. *Iniistius mundicorpus* Gill. P.

Subfamily E.—MALAPTERINÆ.

Genus 24.—**Malapterus** Cuv. & Val.

75. *Malapterus reticulatus* Cuv. & Val. V.

Subfamily F.—SCARINÆ.

Genus 25.—**Cryptotomus** Cope.

76. *Cryptotomus dentiens* Poey. W. (Synonymy doubtful.)
77. *Cryptotomus retractus* Poey. W., S. (Synonymy uncertain.)
78. *Cryptotomus ustus* Cuv. & Val., W., S., B.
79. *Cryptotomus auropunctatus* Cuv. & Val. B.
80. *Cryptotomus beryllinus* Jordan & Swain. W.
81. *Cryptotomus roseus* Cope. W., B.

Genus 26.—**Calotomus** Gilbert.

82. *Calotomus xenodon* Gilbert. P.

Genus 27.—**Callyodontichthys** Bleeker.

83. *Callyodontichthys bleekeri* Steindachner. W.

Genus 28.—**Sparisoma** Swainson.

84. *Sparisoma cretense* (Linnæus). E.
85. *Sparisoma strigatum* (Günther). W.
86. *Sparisoma flavescens* (Bloch & Schneider). W., S.
87. *Sparisoma frondosum* (Cuvier). W., B. (Species perhaps including more than one.)
88. *Sparisoma brachiale* (Poey). W.
89. *Sparisoma maschalespilos* (Bleeker). W.
90. *Sparisoma aracanga* (Günther). W. (Doubtful species.)
91. *Sparisoma chrysopterum* (Bloch & Schneider). W.
92. *Sparisoma lorito* Jordan & Swain. W.
93. *Sparisoma viride* (Bonnaterre). W.
94. *Sparisoma aurofrenatum* (Cuv. & Val.). W.
95. *Sparisoma abildgaardi* (Bloch). W.

95 *b*. *Sparisoma distinctum* (Poey). W. (Doubtful species.)

96. *Sparisoma niphobles* Jordan & Bollman. W.
97. *Sparisoma hoplomystax* (Cope). S., W., B.
98. *Sparisoma radians* (Cuv. & Val.). W.
99. *Sparisoma xystrodon* Jordan & Swain. W., S.

Genus 29.—**Scarus** Forskål.

100. *Scarus punctulatus* Cuv. & Val. W.
101. *Scarus bollmani* Jordan & Evermann. S.
102. *Scarus tæniopterus* Desmarest. W.
103. *Scarus aracanga* (Günther). W. (Doubtful species.)
104. *Scarus trispinosus* Cuv. & Val. W.
105. *Scarus acutus* Poey. W.

105 *b*. *Scarus cuzamilæ* Bean. W.

106. *Scarus vetula* Bloch & Schneider. W.
107. *Scarus croicensis* Bloch. W., S.
108. *Scarus evermanni* Jordan. S.
109. *Scarus flavomarginatus* Cuv. & Val. W.
110. *Scarus cœruleus* Bloch. W., S.
111. *Scarus cœlestinus* Cuv. & Val. W.
112. *Scarus simplex* Poey. W.
113. *Scarus pleianus* Poey. W.
114. *Scarus guacamaia* Cuvier. W., S.
115. *Scarus perrico* Jordan & Gilbert. P.

UNIVERSITY OF INDIANA,
March 20, 1890.

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[NOTE.—The references are to page-figures in brackets.]

8.—ON SOME LAKE SUPERIOR ENTOMOSTRACA.

By S. A. Forbes.

(With 4 plates.)

It seems hardly creditable to American zoology, or to the present tendency of zoological research among us, that the minute animal life of the greatest body of fresh water on the globe should be less fully known than that of scores of insignificant European lakes, or even of many a wayside pool. While our students eagerly engage, often at arm's length and under almost prohibitory disadvantages, in merely imitative work on the problems most prominent in the laboratories of the Old World, we leave untouched, at our very doors, virgin fields of research which must deeply stir the envy of the active group of zoologists who have lately enriched science with a mass of new and highly significant knowledge of the lake fauna of Europe.

It is especially with the hope of calling more general attention to the animal life of our own larger lakes that I present here a preliminary description of the product of a few hauls of the surface net made in August, 1889, from piers and breakwaters, during a hurried trip along the south shore of Lake Superior. The only points from which it was possible for me to make even these imperfect collections were the little town of l'Anse (at the head of Keweenaw Bay), Marquette, and White Fish Point. I improved also a brief opportunity to use the net from a skiff in Lake Michigamme, in Marquette County, a few miles south of the great lake, with which its waters are connected only by way of the Menominee River and Lake Michigan.

The only published information on the Entomostraca of Lake Superior is that given by Prof. S. I. Smith, of Yale, fifteen years ago, in the Report of the U. S. Fish Commissioner for 1874,* and there but four species of the free-swimming forms of these minute Crustacea are positively identified. Concerning the entomostracan fauna of the Great Lakes in general, we have brief papers by Professor Birge † and myself ‡ on species

*Sketch of the Invertebrate Fauna of Lake Superior, p. 690.

† "Notes on Cladocera." Trans. Wis. Acad. Sci., 1876–'77, p. 77. "Notes on Crustacea in Chicago Water Supply, with Remarks on the Formation of the Carapace." Chicago Med. Jour. & Examiner, xvi, pp. 584–590 (Dec., 1881).

‡ "On Some Entomostraca of Lake Michigan and Adjacent Waters." Amer. Nat., xvi, pp. 537, 640.

from Lake Michigan, mention of a single doubtful form in De Kay's Zoology of New York, * and a brief article on "Fish Parasites" by Dr. Kellicott. †

In preparing the present notes I have had particularly in mind, besides mere discrimination and description, the biological relations of the species, as dependent on their situations and relative abundance; the origin of the Great Lake fauna, whether immediately and especially marine or common with that of the Northern lakes at large; and the phenomena of the evolution of species in some of the more intricately related groups.

This subject has also its important economic relation. A thorough examination of the minute life of the Great Lakes, with special reference to the distribution, numbers and habits of the species of Entomostraca occurring there, would greatly assist in the solution of some of the difficult problems of practical fish culture. Since it is now demonstrated that our most important fishes are almost wholly dependent, at a critical period of their lives, on a sufficient supply of these small crustaceans, these furnishing to fishes the first food they eat, and continuing for some time to be substantially their only food resource, a knowledge of these little creatures is scarcely less important to the scientific fish culturist than a knowledge of fishes themselves.

Order COPEPODA.

Family CALANIDÆ.

Diaptomus sicilis Forbes (Plate I, fig. 6).

D. sicilis, Forbes. Am. Nat., XVI (1882), pp. 541 (July), 645 (Aug.).

D. pallidus, var. *sicilis*, Herrick. Final report on the Crustacea of Minnesota included in the orders Cladocera and Copepoda (in 12th Ann. Rep. Geol. and Nat. Hist. Surv. Minn. (1883), p. 137).

D. sicilis Underwood. Bull. Ill. State Lab. Nat. Hist., II, 1886, p. 329.

This beautiful species, a model of elegance and symmetry, is perhaps the most abundant entomostracan in my Lake Superior collections—relatively much more common than in the southern waters of Lake Michigan. It is closely similar to *D. gracilis* Sars (a common species of clear lakes in Europe, from northern Italy ‡ to Finland and Scandinavia), but the constancy of the characters which distinguish it warrants its separation. Although it is a decidedly variable form, its observed variations do not appear to include or sensibly approximate the characters of *gracilis*. The two have evidently had a common origin, not very remote; but their present geographical separation, shown by the constancy of their differences, makes it altogether probable that this origin dates from a time when communication between the fresh waters of the

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* Part VI, "Crustacea," p. 62.

† "On Certain Crustacea Parasitic on Fishes from the Great Lakes. Proc. Amer. Soc. of Microscopists," I, pp. 53–57.

‡ Imhof.

northern regions of Europe and of America was more immediate than now—a time, that is, when the lands of the northern hemisphere were more closely connected or less widely sterilized by ice.

The typical form of *sicilis* is larger than *gracilis*, females ranging from 1.3 to 1.6^{mm} in length, without the caudal setæ, while *gracilis* does not commonly surpass 1^{mm}. The fifth and sixth segments of the cephalothorax are very imperfectly divided (no suture being apparent on the back), and the last segment is more deeply emarginate behind than seems to be the case with *gracilis*. There is a single very minute spine at the tip of the lateral lobe of this segment, and sometimes a still more minute one some distance below and within this, on the inner inferior part of the lobe.

In ovigerous females the abdomen has three segments, besides the furca, of which the first is as long as the second and third—the second being the shortest, but still nearly equaling the third. The furca is, in the female, a little longer than the third segment, in the male much longer than the second, the second, third, and fourth abdominal segments in the latter sex being almost exactly equal, and the first a little shorter.

The basal joint of the legs of the fifth pair (Pl. I, fig. 6,) bears, in both male and female, a large cylindrical process, ending with a stout spine or spine-like tip. In the female, the third joint of the outer ramus is scarcely distinguishable as such, being merely a stout spine or hair articulated at the base and without accessory hairs or spines. The large process of the second joint is slightly curved outward. The inner ramus has two long, strong diverging spines, half as long as the ramus, near its tip, this extending beyond their insertion as a smooth, obtuse triangle. Left leg of male without spine on second basal joint or terminal seta on outer ramus. Inner rami of both legs smooth at tip, one- or two jointed. Outer ramus of left leg distinctly two-jointed, the segments equal, the tip a rounded cushion covered with delicate short hairs. A similar hairy pad at middle of inner surface of this segment.

In specimens taken August 9 at Marquette, spots of vivid red about the mouth and at the posterior fourth of the cephalothorax were commonly connected by an indigo-blue or pale red stripe, which included the alimentary canal and often adjacent structures. The ovaries were also often blue, sometimes very bright. Occasionally one was seen with much more red irregularly distributed in the center of the body, and it is probable that earlier in the season red was the prevailing color. The egg masses of the female were blue, varying to red; the eye dark red; the abdomen colorless; and the thoracic legs of a bluish tint.

D. sicilis, var. **imperfectus**, new var.

Occurring commonly with the form above described is another (often certainly adult, as shown by the developed spermatophore in the male and the external egg masses in the female) much smaller in average size, and with the terminal hook of the fifth pair of legs of the male thicker,

stouter, and less regularly curved. I have not been able to find positive and unvarying distinctions between this form and the preceding, and am disposed to regard it as the barely matured adult, reproducing while yet capable of further structural progress. Its average total length, without setæ, is 1^{mm}, the thorax measuring $.7^{mm}$ and the abdomen $.3^{mm}$. The antennæ are relatively longer than in the typical form, extending five or six joints beyond the cephalothorax instead of two or three, as in the other. The inner ramus of the left leg is also relatively longer, reaching to the tip of the outer ramus, while in the typical form it reaches only to the base of the preceding joint.

Both the above are extremely abundant in all the collections made from northern Michigan, and are likewise among the commonest Entomostraca of southern Lake Michigan and adjacent waters. The more highly developed variety is relatively commoner in the Great Lakes, and the imperfect form is the ordinary Diaptomus of the smaller lakes and permanent ponds adjacent. The latter, if either, is to be identified with the insufficiently described *Diaptomus pallidus* of Herrick.*

Epischura lacustris Forbes. (Pl. I, figs. 1–5; Pl. II, fig. 7.)
Amer. Nat., XVI (1882), p. 648.

This remarkable species,† the most peculiar of our fresh-water Copepoda, distinguished from all others known by the modification of several abdominal segments in the male as a sexual grasping organ, was common in both Lake Superior and the smaller lake—most abundant in a collection made at night in the harbor at Marquette.

Among the many hundreds of specimens which I have examined from the Great Lakes and from several of the smaller lakes of Illinois, Michigan, and Wisconsin, I have rarely seen an immature form, still more rarely a female without a spermatophore attached, and never one with an egg sac. The spermatophore (occasionally there are two) is fixed to the female abdomen by a large oval mass of cement, which may be so softened by a solution of potash as to permit the removal of this finger-shaped structure, otherwise easily mistaken for a process of the abdomen itself. The absence of an external egg mass is one of several features of this genus relating it to Heterocope of the lakes of Europe, which genus is indeed its nearest ally.

Specimens taken from Lake Michigamme, August 9, were tinged with red or violet, most deeply in the ventral region, as if a much more brilliant color had largely faded.

The cephalothorax of the male (Pl. I, fig. 1) has but three completely distinct segments, the last being united to that preceding, and that bear-

* 7th Ann. Rep. Geol. and Nat. Hist. Surv. of Minn. (1878), p. 91.

† Two additional species of this genus, *E. nevadensis* Lillj. and *E. nordenskiœldi* Lillj., the former from lakes in the Sierras and the latter from Newfoundland, have lately been published in *Revision des Calanides d'Eau Douce*, par Jules de Guerne et Jules Richard, pp. 92–96 (Paris, 1889).

ing the third pair of legs alone being free. Beneath, however, all the leg-bearing segments except the last are marked off by sternal sutures.

The head is distinguished by a transverse constriction, but without suture, and the antennal region is similarly marked off from the remainder of the head. The eye is distinctly double in structure, with but little pigment.

Owing to modification and distortion of the male abdomen (Pl. I, fig. 1; Pl. II, fig. 7) its segmentation is difficult to make out, but the muscular structure shows that there are but four free segments. Of these the second and third are laterally produced to form a large chela, and the fourth bears the toothed and broadly paddle-shaped processes previously described,* the former of these springing from the ventral portion of the segment and the latter from the dorsal. The base of the right ramus of the furca is concave without to adapt it to these structures, the whole abdomen being evidently strongly flexed to the right when this complicated apparatus is in use. There are but three developed plumose setæ at the tip of each ramus, and besides these a short, stout tooth at the outer distal angle, and a delicate simple hair at the inner.

The antennæ are twenty-five jointed, and reach about to the third segment of the abdomen. The median joints of the female antennæ and of the left of the male are thickened at the articulations, giving them a slender hour-glass form.

The right antenna of the male is apparently twenty-one jointed, the thirteenth to the eighteenth segments are dilated, and the nineteenth segment is hinged upon the preceding. Both antennæ are richly supplied with sensory structures, which have the form of two- or three-jointed hairs, with very delicate terminal segments, no olfactory clubs occurring. The basal segments of these hairs on the first and third joints are especially large and long, and contain distinct cells and finely granular matter. The terminal joint of each antenna is lobed at tip, with six long hairs; and there are four such hairs on the penultimate joint.

The antennules are short, the ramus apparently but three-jointed, the short median joints common in this appendage being only obscurely indicated. The second joint is as long as both the other two, the first is very short, the third about three-fourths the second. The ramus bears four terminal and four lateral long curved plumose hairs.

Before the mouth opening is a vaulted labrum, opposed to a similar elevation behind, the mandibles fitting into the transverse cleft between these lips.

The mandibular palpus (Pl. I, fig. 4) is three-jointed, the first and last joints very short, each about a fourth of the length of the middle one. The greatest width of the latter is contained about twice in its length. The tip of the palpus bears six long plumose hairs, with a cluster of four shorter ones near it. The ramus is short, twice as long as the third joint, obscurely four-jointed, and bears three long plumose terminal hairs and three longer lateral ones.

* Amer. Nat., *loc. cit.*

First maxilliped stout and short, about four times as long as wide. Three distinct joints or segments, with a number of small indefinite articles compacted at the tip, this last bearing four long, stout, curved, parallel bi-pennate setæ, and two smaller ones not in the same series. Proximal joint the longest, the second shortest, about half as long as the third, the latter two thirds the first. The second joint bears two plumose setæ and the third joint three, the two basal of these upon a separate lobe. The latter joint bears also a fourth short stout seta inserted near the lower one.

The second maxilliped has three lobes on the anterior margin of the basal joint, each bearing two long, stout, coarsely plumose bristles, with their barbs extending forwards. The second joint bears one very long and one short plumose bristle at the anterior inferior angle. The remaining joints, together about as long as the second joint, bear five long and two shorter plumose bristles.

The first four pairs of legs (Pl. I, fig. 5) are similar, the outer ramus three-jointed, and the inner one-jointed. The last joint of the outer ramus of the first pair is about as long as the two preceding, and the tip of the inner ramus reaches about to the middle of the second joint of the outer. The outer ramus of the fourth pair of legs (Pl. I, fig. 5) has two teeth at the outer tip of each of the two basal joints. The terminal joint of this ramus is armed as follows: A short, simple spine at middle of outer margin, and another at the distal outer angle; a single large and long terminal seta, strongly and sharply toothed externally and plumose within; and four long plumose setæ attached to the inner margin. The inner ramus bears two terminal and three internal plumose setæ. The left leg of the fifth pair in the male (Pl. I, fig. 3), viewed from behind, has the basal joint very large, broader than long, with the inner inferior angle produced downwards as a long, stout, curved process or arm, as long as the two remaining joints. The second joint is trapezoidal, shortest within. The third joint is about half as wide at base as the first, is straight without, with a sharp small tooth at its distal third, and bifid at tip. On the inner margin this joint is at first dilated a little and then deeply excavated to the narrow tip, to receive the lower end of the left leg, the lower two thirds of this margin forming the segment of a circle.

The marked distinction of this genus points to a separation from the stock common to it and Heterocope earlier than that of our other characteristic species of Calanidæ, and a much earlier appearance in its present habitat than that, for example, of the following species, which, like Epischura, is without egg sac.

Limnocalanus macrurus Sars, var. **auctus**, new var.

Amer. Nat., XVI (1882) p. 648.

This large calanid, very abundant at times in the southern end of Lake Michigan, and occurring also in Geneva Lake, Wis., I found twice in Lake Superior, at Marquette. Our specimens differ constantly

from the European, so far as I have seen, in a few slight particulars—especially interesting because of their minute and trivial character; but in every detail of any importance the New and Old World individuals are alike, so far as I can judge from the original description of Sars* and from the amply illustrated paper of Nordqvist.†

The minute terminal segment of the antennæ, the twenty-fifth of the European form, is in our examples consolidated with the preceding, so that there are but twenty-four segments, and numbers 8 and 12 are without the hook-like spines mentioned by Nordqvist. The armature of the mandible is somewhat reduced, consisting in the American form of seven short teeth, the two lower acute and widely separated, and the five remaining blunt and emarginate at tip. At the upper end of this series is a slender, acute tooth, and a small simple hair. There is no row of accessory spines on the mandible, as figured by Nordqvist.

The slight differences noted are in the direction of a higher specialization, and suggest, as do those of the Diaptomi, that our American variety has had a more rapid course of development than the European.

In the Old World, Limnocalanus has been found only in the larger lakes of Finland and Scandinavia, and in the gulfs of the Baltic (Finland and Bothnia). It seems to have been distributed in company with *Diaptomus sicilis*, and later than Epischura; and is probably now isolated from its European brotherhood—a geographical variety on the way to become a species.

Family HARPACTIDÆ.

Canthocamptus, sp.

Only a few specimens of this genus of minute Copepoda have been found in my Lake Superior collections, and in the one from Lake Michigamme—a number too small to permit a study of the species.

Family CYCLOPIDÆ.

Cyclops thomasi Forbes. (Pl. II, fig. 8.)

Cyclops thomasi Forbes, Amer. Nat. xvi (1882), p. 649; Cragin, Trans. Kan. Acad. Sci., viii (1882–'83), pp. 68–70.)

This well-marked species—the commonest of Lake Superior, where it is the usual companion of the Great Lake Diaptomi—was taken in nearly every haul, often in countless numbers. It is a species of clear water and the open lake, and was far less frequent at L'Anse Bay than at Marquette and White Fish Point. In Lake Michigamme it was not seen.

Cyclops gyrinus, n. sp. (Pl. II, fig. 9; Pl. III, fig. 14).

A stout, heavy species, with long first segment, strongly arched

*Oversigt af de indenlandske Ferskvandscopepoder. Forhand. i Vidensk.-Selsk. i Christiania, p. 226.

† Die Calaniden Finlands, p. 31.

cephalothorax, short furca, well-developed terminal setæ, and seventeen-jointed antennæ, reaching the abdomen, with acute ridge on the three distal joints, that on the last serrate. (Pl. III, fig. 14.)

Total length 1.8^{mm}, cephalothorax 1.1^{mm} long, .63^{mm} wide, and .43^{mm} high; abdomen and furca .7^{mm} long, equaling the longest bristle.

Basal segment of antennæ without circlet of minute hairs, the second segment short, the third shorter, the fourth equal to the second and third together, the fifth a little longer than the second, the sixth equal to the third, the seventh slightly longer than the fifth and sixth together; segments eight to eleven sub-equal, increasing a little in length, twelve to fourteen a little longer, fifteen to seventeen much longer. Antennules with line of delicate hairs inclosing a patch on posterior surface of each segment, elongate oval on all but the proximate, where it is circular.

Labrum with twelve conspicuous teeth, the second from each end decidedly larger than the others.

The swimming legs with all the rami three-jointed. The first pair (Pl. II, fig. 10) with the segments of the outer ramus about as broad as long, the terminal segment with one spine and two spine-like setæ at tip, two spines without and three setæ within; the other segments all with one spine and one seta. The inner ramus with one very stout spine at tip and one very slender seta not longer than the spine, one seta without and three within on the distal segment; the basal segment of this ramus with one seta and the second with two.

Second pair of legs with two very stout spines and a slender seta at tip of the last segment of the outer ramus, two stout spines without and four setæ within. The armature of the inner ramus like that of the preceding.

Outer ramus of the third pair of legs with two spines and one seta at tip (the inner spine the longer), three spines without and four setæ within; the inner ramus as before.

In the fourth pair of legs (Pl. II, fig. 11), the outer ramus has two spines and one bristle at tip (the bristle shorter than the longer spine), one spine without and four bristles within, the lower of the latter abortive. The inner ramus has the last joint slender, truncate, with two stout spines at tip, the outer one the larger, with one seta without and two within.

The fifth pair of legs (Pl. II, fig. 12), are jointed, the basal segment two thirds as wide as long, its outer margin straight, its inner, convex and minutely hairy. The distal end is truncate, with a very long seta at the outer distal angle. The second (terminal) segment is about as long as the preceding is wide, lobed in the middle, and tri-setose, the outer seta shorter than the inner, and the latter about half as long as the median.

Abdomen short, the greatest breadth but twice in length, the furca short and broad, the rami half as wide as long, about as long as the two

last segments of the abdomen. The inner terminal bristle three times as long as the outer, three fifths as long as the outer median, and about two fifths the length of the longest. A transverse row of spinules at the base of the outer seta; the distal end of the last abdominal segment dentate; and the distal end of the segment preceding with a few teeth at the sides.

Last thoracic segment minutely dentate on posterior margin.

This species is allied to *coronatus*, from which it is distinguished (among other characters) by the absence of the dentations of the antennal segments, which gave the latter its name, by the absence of cilia on the inner surfaces of the rami of the furca, and by the much smaller size.

Described from several specimens (females) taken inshore at the head of Keweenaw Bay on the south shore of Lake Superior.

Cyclops edax, n. sp. (Pl. III, fig. 15; Pl. IV, figs. 16–19.)

A small species, usually more or less pigmented, moderately robust, with short furca, subequal caudal setæ, seventeen-jointed antennæ, and unusually prominent maxillipeds.

Length, without caudal setæ, 1.1^{mm}.

Cephalothorax oval, rather compact, broadest before the middle; first segment as long as the remainder; back moderately arched. Last thoracic segment scarcely broader than the first abdominal, slightly emarginate at the sides. First abdominal segment (Pl. III, fig. 15) very long, equaling the following three; last segment shortest, with a row of spinules at the posterior margin. Rami three eighths as wide as long, nearly twice the length of the last segment. The lateral spine a trifle behind the middle, the outer seta about as long as the ramus, the inner five sixths the length of the third from within, the latter two thirds as long as the second.

The antennæ reach to the fourth thoracic segment and are without serrations, acute ridges, or other special armature, except a stout spine at the tip of the sixth segment. The basal joint is as long as the three following, and the last three joints are about as long as the six preceding, joints sixteen and seventeen being equal, and fifteen four fifths as long as sixteen. The fourth segment is as long as the fifth and sixth together, and the seventh a little longer. The tenth segment is wholly destitute of hairs and bristles. The antennules are slender, the first and second segments not distinctly articulated, the first twice as long as the second, the third and fourth equal to each other, and to the first. The two last segments minutely hairy on the posterior surface, except a little space near the tip of the last.

The first maxilliped is unusually long and slender, the basal segment being very nearly three times as long as wide, and the whole appendage as long as the last five antennal joints.

The last segment of the outer ramus of the legs of the first pair (Pl. IV, fig. 16) bears one spine and two setæ at tip, one spine without and

two setæ within. The inner ramus has at the tip of the last joint one stout spine and one slender seta, one seta without and three setæ within. The legs of the second and third pairs are armed alike, the terminal segment of the outer ramus in each bearing a slender seta and two spines at tip (the inner of these the longer, and the seta a little longer still), and one spine without and three setæ within. The inner ramus like the outer, except at the tip, where there is a single stout spine and a single seta. In the fourth pair of legs the last joint of the outer ramus bears two terminal spines and one seta, one spine on the outer margin and three setæ on the inner. The corresponding joint of the inner ramus is very narrow, has two spines at the tip, one seta without and two setæ within. The outer margin of this last segment is minutely hairy above the marginal seta. The rudimentary fifth foot is small, two-jointed, the first joint half as long as the second, twice as broad as long, with a slender simple bristle at the outer distal angle; the second joint with two setæ, the outer simple, longer than the preceding, the inner plumose and longest of all.

By its seventeen-jointed antennæ and two-jointed fifth foot with two terminal bristles, this species is related to *C. simplex* Pog., from which it is, however, readily distinguishable by the shorter last joints of the antennæ and the absence of the knife-like ridge. The proportions of the joints of the antennules, and the plumose terminal setæ of the fifth foot are additional distinctive characters.

This Cyclops was taken in moderate numbers from Lake Michigamme only.

Cyclops agilis Koch.

Amer. Nat., XVI (1882), p. 649.

This wide-spread Old World species, reported from England to Russia and Turkestan, and from Scandinavia to the Tyrol, and also known in this country from Massachusetts to Illinois and Minnesota, occurred in my Lake Superior collections from Marquette.

Cyclops pectinifer Cragin.

Trans. Kans. Acad. Sci. (1883) p. 71.

I have had no difficulty in distinguishing Professor Cragin's species described under this name* from the very closely related form last mentioned, although it is possible that larger collections of both might show them intergrading. This was the commonest Cyclops in the collections made at l'Anse.

Order CLADOCERA.

Family POLYPHEMIDÆ.

Polyphemus pediculus L.

In this curious crustacean, not uncommon in clear shallow lakes and ponds in Europe, we have an example of an immigrant, which has not

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*A Contribution to the History of the Fresh-Water Copepoda. Trans. Kan., Acad. Sci., VIII, p. 66.

varied, that I can see, in any particular since its advent here, my specimens from l'Anse Bay, Marquette, and White Fish Point agreeing precisely with the specific descriptions and figures of P. E. Müller,* Lilljeborg,† and Schoedler.‡ Even the rudimentary legs of the fourth pair, although more swollen than in Müller's and Lilljeborg's figures, are similarly lobed, and bear the same armature; and the coxal tuberosities noted by Müller are also present.

My examples differ, on the other hand, from Leydig's plates and descriptions in the presence of four curved spines instead of three at the tip of each of the first three pairs of legs, and in the number of plumose bristles on the antennæ,—seven on each ramus in ours, while in Leydig's *oculus* there are eight on the outer ramus. These distinctions of *pediculus* and *oculus* have already been noticed by Schoedler, but subsequent writers have considered them insignificant, and bring all known forms of Polyphemus under one specific name.

In this country, this species has been reported previously from Massachusetts (Birge) and from Minnesota (Herrick).

Family LEPTODORIDÆ.

Leptodora hyalina Lillj.

A beautiful and interesting species, likewise common to the northern parts of both worlds, and equally abundant in both, occurred frequently in my Michigan collections, although much more abundantly in Lake Michigamme than in Lake Superior. Great numbers were taken in the former lake, *at the surface*, on a bright day, with high wind, at 3 p. m.

Family LYNCEIDÆ.

Eurycercus lamellatus O. F. M.

Identical with the European species. Taken in Marquette harbor and l'Anse Bay.

Acroperus leucocephalus Koch.

From l'Anse Bay.

Alona sp.

A very few specimens of this difficult genus were taken, usually in numbers too small for precise determination. *A. oblonga* P. E. M., and others allied to *modesta* Hk., and *quadrangulata* P. E. M., occurred at Marquette and at White Fish Point, and still another form was taken in Lake Michigamme.

Pleuroxus procurvus ? Birge.

Trans. Wis. Acad. Sci., IV (1877), p. 92.

To this species I assign doubtfully a few specimens taken at Mar-

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* Danmark's Cladocera, p. 200.

† De Crustaceis ex ordinibus tribus Cladocera, Ostracoda et Copepoda, in Scania occurrentibus, p. 62.

‡ Neue Beiträge zur Naturgeschichte der Cladoceren (Crustacea Cladocera), p. 67.

quette and l'Anse differing from those described by Professor Birge only in slight detail. None of the striæ of the shell take a direction to meet the ventral margin at right angles, but all incline backwards; the plumose setæ of the ventral margin are not sparse, but are placed as thickly as they can stand; and the anterior margins of the shell are not dentate, but the setæ there are articulated by greatly thickened bases.

Chydorus sphæricus Baird.

Taken frequently in small numbers in both lakes.

Chydorus rugulosus n. sp.

Allied to *C. sphæricus*, but with the depth only three fourths the length, the pigment speck nearly or quite as large as the eye and half as far from the eye as from the tip of the rostrum, and the hexagonal shell-areas marked by a delicate reticulum of minute rugosities.

Shell highest at middle, scarcely truncate posteriorly, but the hind margin rounding broadly into the lower, the anterior dorsal surface flattened, meeting the flattened valves at an acute projecting angle, giving the shell a trigonal form like that of a beech nut. The dorsal outline not uniform, but flattened in front. Submarginal row of hairs along the ventral edge rather coarse and strong—about four to the length of a marginal hexagonal area. Surface of the shell everywhere distinctly reticulate, bearing besides the coarse hexagonal reticulations, a very fine but distinct net-work of minute rugosities, the meshes of which are longest in the direction of the margin of the shell.

The labial appendage long, reaching as far as the tip of the rostrum, and as broad at the base as high. The posterior inferior angle produced and extending slightly backwards, the whole quite different in form from that of *C. sphæricus*.

Post-abdomen short, broad, inferior margin broadly rounded, with nine or ten simple, stout teeth. Anal tubercle forming an acute angle; the caudal claw smooth, with a small basal tooth, the length of which is about equal to the diameter of the claw.

Length, $.5^{mm}$; depth, $.38^{mm}$; width, $.33^{mm}$.

Collected in considerable number from the surface in Marquette harbor at 5 a. m., August 11, 1889, and less abundantly August 9.

Chydorus globosus Baird.

Seemingly less abundant than the preceding. Noticed only at l'Anse.

Bosmina longirostris O. F. M.

A few specimens of this common species—the only one of its genus noticed—were taken repeatedly at Marquette, at White Fish Point, and at l'Anse.

Family DAPHNIIDÆ.

Scaphloberis mucronata O. F. M.

This abundant European entomostracan occurred in the very miscellaneous collections from l'Anse, but was not noticed elsewhere.

Daphnia retrocurva Forbes, var. intexta.

This form, although remarkably constant in the collections made in northern Michigan, both from Lake Michigan and the smaller lakes, differs from *retrocurva*,* previously described, only in the inferior development of the head and the smaller size and number of the pectinations of the caudal claw. It is probably to be regarded as a slightly depauperate form of *retrocurva.*

The head, averaging two fifths the length of the body without the spine, is helmeted, triangular, the apex antero-dorsal, recurved. Its dorsal outline otherwise nearly straight or slightly concave; lower margin sometimes slightly sinuate near the rostrum, the latter produced to or beyond the tips of the sensory hairs. Length of the borders of the head subequal, but the antero-ventral margin commonly the longest. Pigment speck wanting. Eyes small, about half as far from lower as from upper margin of the head, and either equidistant from rostrum and apex, or a little nearer the former. Viewed from above, the head is about half as thick at base as it is long.

Dorsal outline of the body more or less convex, spine in the adult nearly or quite equal to the depth of the valves. The latter about three fourths as deep as long, surface conspicuously reticulate, lower margin very slightly spinose, with sparse, short appressed teeth, which are continued on to the terminal spine. Dorsal abdominal processes quite distinct at base, brood cavity with one or two eggs. The caudal claws bear a row of conspicuous teeth on the basal half, about twelve in number, in two sets, those of the distal set the larger. (In *retrocurva* these teeth are about twenty in number, the smaller proximal set twelve to fourteen, and the distal more conspicuous set, about eight in number.) Beyond these a row of very fine hairs continued nearly to the tip of the claw. Posterior outline of the post-abdomen regular, bearing nine or ten curved spines.

Total length, without spine, about 1.6^{mm}.

This was the only Daphnia taken in the longshore collections in Lake Superior and in Lake Michigamme—the latter being, it will be remembered, a body of water not directly connected with Lake Superior, but emptying through the Menominee River into Lake Michigan.

This form adds to the characters of the section *Hyalodaphnia* the pectinate claw of the group to which *D. pulex* belongs. It is distinguished from *D. pellucida* at once by the armature of the claw and the lack of the pigment speck; from *cucullata* and its varieties by the same characters and by the fact that the dorsal abdominal processes are distinct at base. From *hyalina* and *galeata* it is separated by the lack of the pigment speck and the form of the head.

This Daphnia stood next in abundance in my Lake Superior collections to *Cyclops thomasi*, Diaptomus, and Epischura, occurring in large or moderate number in every haul.

* American Naturalist, XVI (1882), p. 642.

Daphnia lævis Birge.

A single specimen of this strictly American species occurred in my Lake Michigamme collections.

Daphnella brachyura Lievin.

Excessively abundant in Lake Michigamme, where it was the commonest crustacean, but not noticed in the Lake Superior material.

Sida crystallina O. F. M.

Very abundant in the rather dirty waters of l'Anse Bay, but not seen elsewhere.

Holopedium gibberum Zaddach.

A very remarkable form included among the pelagic species of the European lakes, and hitherto reported in America only from the deeper waters of Lake Michigan.* Taken in moderate number at l'Anse, in shallow water from the pier.

The following lists will show how the species above mentioned were associated under the circumstances represented by my collections:

Marquette breakwater, August 9, surface, shallow water, sandy bottom, bright weather, good wind. Fairly full collections.

Diaptomus sicilis, very abundant.
imperfectus, very abundant.
Epischura lacustris, a few.
Limnocalanus macrurus, rare.
Cyclops thomasi, common.
Polyphemus pediculus, very rare.
Chydorus sphæricus, few.
rugulosus, few.
Bosmina longirostris, few.
Daphnia intexta, not uncommon.

Off Light-House Point, near Marquette, August 9, 3 p. m., deeper water, sandy bottom, bright weather, high wind. Net hauled at a depth of about 40 feet. Collection scanty.

Diaptomus sicilis, common.
imperfectus, common.
Epischura lacustris, a few.
Limnocalanus macrurus, a few.
Cyclops thomasi, a few.
Leptodora hyalina, very few.
Bosmina longirostris, several.
Daphnia intexta, a few.

Marquette breakwater, August 11, at 5 a. m., clear, still. A scanty collection.

Diaptomus sicilis, common.
imperfectus, common
Canthocamptus, sp., a few.
Cyclops thomasi, common.
Chydorus rugulosus, several.
Bosmina longirostris, many.
Daphnia intexta, few.

Marquette harbor, August 11, 9 p. m., clear, calm, shallow water, surface. A large collection.

Diaptomus sicilis, very abundant.
imperfectus, very abundant.
Epischura lacustris, common.
Cyclops thomasi, common.
agilis, less abundant.
Eurycercus lamellatus, several.
Alona oblonga, few.
Pleuroxus procurvus, few.
Chydorus sphæricus, few.
Bosmina longirostris, several.
Daphnia intexta, many.

* "On some Entomostraca of Lake Michigan and Adjacent Waters." Amer. Nat., XVI, p. 641.

L'Anse Bay, August 14, 1 p. m., pier, shallow water, somewhat weedy and dirty. A swift stream entering about a quarter of a mile above. Still. Sun and shower. A good collection.

Diaptomus sicilis, common.
imperfectus, common.
Canthocamptus, sp., very few.
Cyclops thomasi, few.
gyrinus, a few.
pectinifer, several.
Polyphemus pediculus, many.
Leptodora hyalina, several.
Eurycercus lamellatus, few.
Acroperus leucocephalus, few.
Alona, sp., several.
Pleuroxus procurvus, a few.
Chydorus globosus, a few.
Bosmina longirostris, several.
Scaphœleberis mucronatus, several.
Daphnia intexta, several.
Simocephalus vetulus, few.
Sida crystallina, abundant.
Holopedium gibberum, several.

White Fish Point, August 15, shallow water, sandy bottom, sun, high wind. Fair collection.

Diaptomus sicilis, common.
imperfectus, common.
Cyclops thomasi, abundant.
Polyphemus pediculus, several.
Leptodora hyalina, a few.
Alona oblonga, a few.
Alona, sp., a few.
Chydorus sphœricus, few.
Bosmina longirostris, few.
Daphnia intexta, several.

Lake Michigamme, August 8, 3 p. m., sun, high wind. At surface and about 15 feet below. Very large collection.

Diaptomus sicilis, common.
imperfectus, common.
Epischura lacustris, common.
Canthocamptus, sp., a few.
Cyclops edax, a few.
Leptodora hyalina, many.
Alona, sp., a few.
Chydorus sphœricus, a few.
Daphnia intexta, several.
lævis, rare.
Daphnella brachyura, very abundant, below the surface.

The facts now known concerning the animal life of the Great Lakes furnish an insufficient basis for a final discussion of the origins of this fauna, but may nevertheless serve to indicate the general lines within which such a discussion must proceed. There are three such principal origins possible; some of the Great Lake species may have made their way directly from the sea, undergoing meanwhile more or less modification; others may be a part of a general north-temperate fauna, whose formerly continuous area of distribution has been broken up by changes of level and climate, with consequent organic differentiation; and others may have had an independent southern and southwestern origin, possibly reaching back, in some instances, to a South American starting-point.

Too little is as yet known concerning our southern Entomostraca, or even those of our Atlantic and Pacific coasts, to make it possible to point out with any assurance the elements of the Great Lake fauna which are to be referred to these origins, and we can only undertake to show which are related to the much better known fauna of the lakes of northern Europe.

Three of the four Calanidæ now reported from our Great Lakes are so closely related to those of European lakes as to leave not the slight-

est doubt that they have had a relatively recent origin in common with these Old World species. On the other hand, the points of difference between our species and their European representatives, though slight and scarcely entitled to specific rank unless on the ground of their constancy, indicate a separation long enough ago to permit at least incipient differentiation. These facts seem to point to an origin connected with the "glacial period"—whether immediately subsequent to that period, as suggested by Herrick,* or just previous to the time of actual glaciation, when the milder climate and the greater land elevation northward† permitted a freer passage than now of fresh-water forms across the north Atlantic, it would seem impossible to say until we know more of the present northward limit of distribution of the species concerned. If they now range far up into the arctic regions, it would seem possible that they may have lived everywhere in the icy waters of the time of diminishing glaciation; but if their habitat is strictly subarctic or temperate, their area can not have been continuous with that of the European species since pre-glacial times.

That Epischura must have had a different history is a fact already noticed, and considering the fact that its nearest known relative, Heterocope, is both fresh water and marine, it is not unlikely that it came to us from the sea.

The four or five Cyclopidæ of this paper, it will be noticed, are all American but one; but this large and difficult family has been far too little studied to permit generalization, the current descriptions of even the more abundant species not commonly being given in sufficient detail to permit careful comparison.

The list of Cladocera, on the other hand, is remarkable for the number of unaltered European species which it contains, all but four of the sixteen here reported being quite indistinguishable from those described from Europe, while the four excepted have very closely allied Old World kindred.

Finally I would remark upon the minuteness and physiological insignificance of the changes which so far seem to separate several of our Entomostracan species from their European representatives. If more extended collections and exhaustive study should show that the dif-

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* List of the Fresh-Water and Marine Crustacea of Alabama, with Descriptions of the New Species and Synoptical Keys for identification, p. 49.

† "The progress of events seems to have been about as follows: In the warm period preceding the Glacial epoch, when the vegetation of the temperate zone flourished about the north pole, there was land connection between the continents, permitting the larger species of the Old World to migrate to North America. At the same time the conditions in North America were favorable to the tropical species of animals which had developed and flourished in South America. The refrigeration of the climate on the approach of the Glacial period, and the advance of the ice from the north, cut off retreat to the Old World species, and gradually hemmed them in over the southern portion of the continent, where all forms of life were compelled to re-adjust themselves to new conditions.—(C. Frederick Wright, in "The Ice Age in North America," p. 387.)

ferences now apparent are indeed constant; if the presence or absence in the adult of that rudiment of the larval eye known as the pigment speck, a slight increase or decrease in the size or number of teeth on the caudal claws, the presence or absence of a suture between two successive antennal joints, and other equally trivial differences, serve really to distinguish animal groups which have been separated from each other by the physical division of their area of distribution, we shall have additional illustrations of the rise of specific and other distinctions as an indirect consequence of simple isolation.

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[Note.—The references are to page figures in brackets.]

EXPLANATION OF PLATES.

PLATE I.

FIG. 1. *Epischura lacustris.* Male.
2. Same species, female. Fifth pair of legs.
3. Same species, male. Fifth pair of legs.
4. Same species. Mandible with palpus.
5. Same species. Fourth pair of legs.
6. *Diaptomus sicilis.* Female. Fifth pair of legs.

PLATE II.

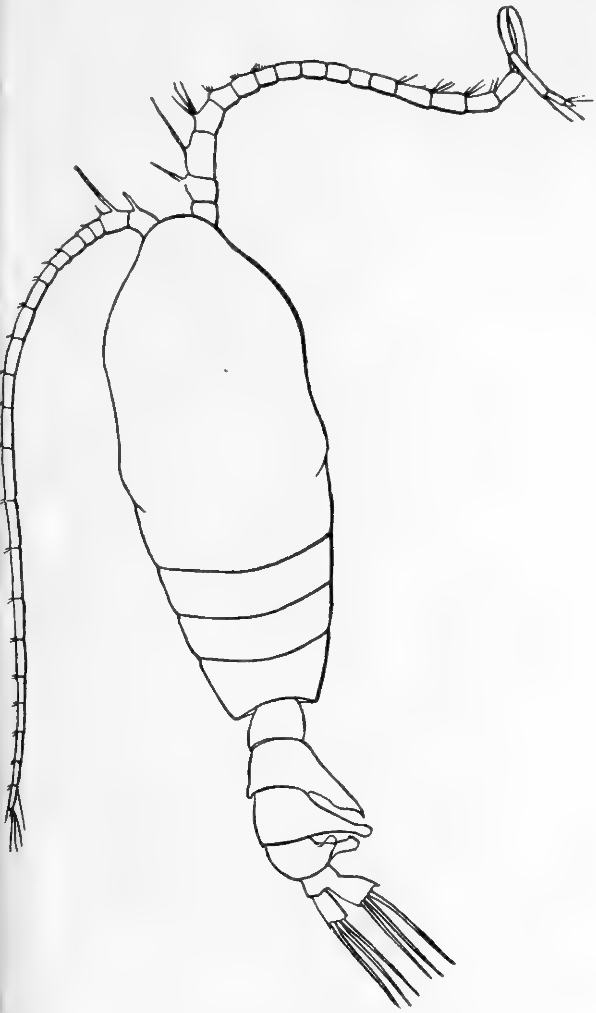
FIG. 7. *Epischura lacustris.* Abdomen of male.
8. *Cyclops thomasi.* Female.
9. *Cyclops gyrinus*, n. sp. Female.
10. Same species. Leg of first pair.
11. Same species. Leg of fourth pair.
12. Same species. Leg of fifth pair.

PLATE III.

FIG. 13. *Leptodora hyalina* (after Lilljeborg).
14. *Cyclops gyrinus*, n. sp. Female. Terminal joints of antenna.
15. *Cyclops edax*, n. sp. Abdomen of female.

PLATE IV.

FIG. 16. *Cyclops edax*, n. sp. Leg of first pair.
17. Same species. Leg of third pair.
18. Same species. Leg of fourth pair.
19. Same species. Leg of fifth pair.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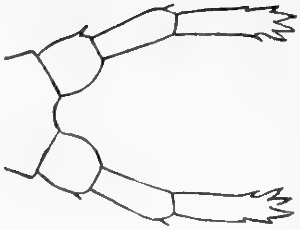
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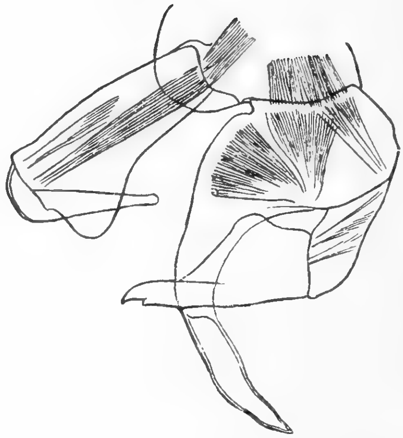
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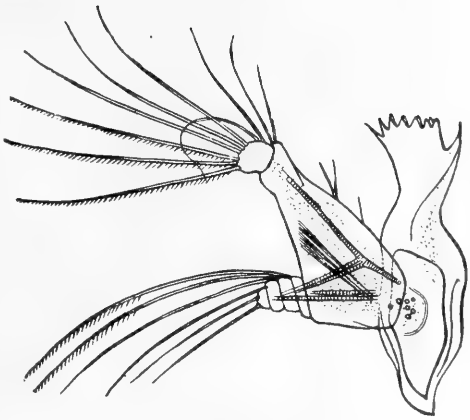
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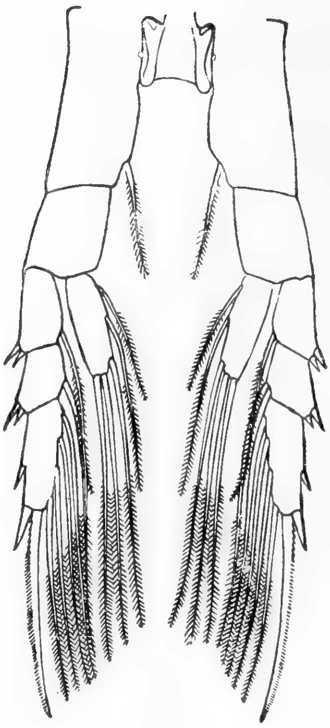
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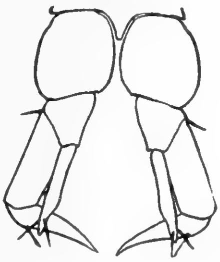
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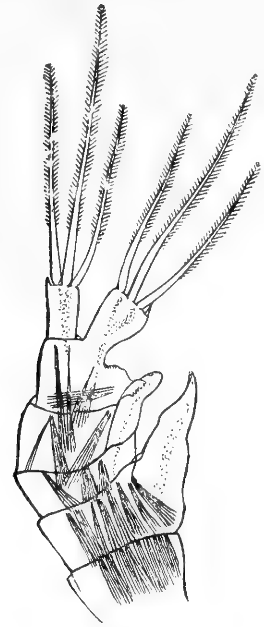
PLATE II.



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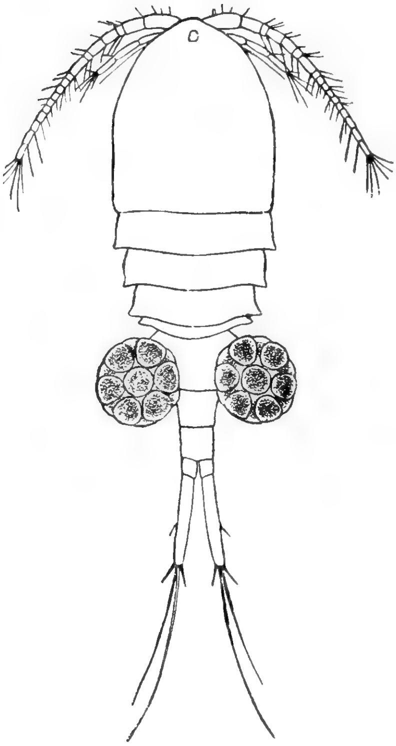

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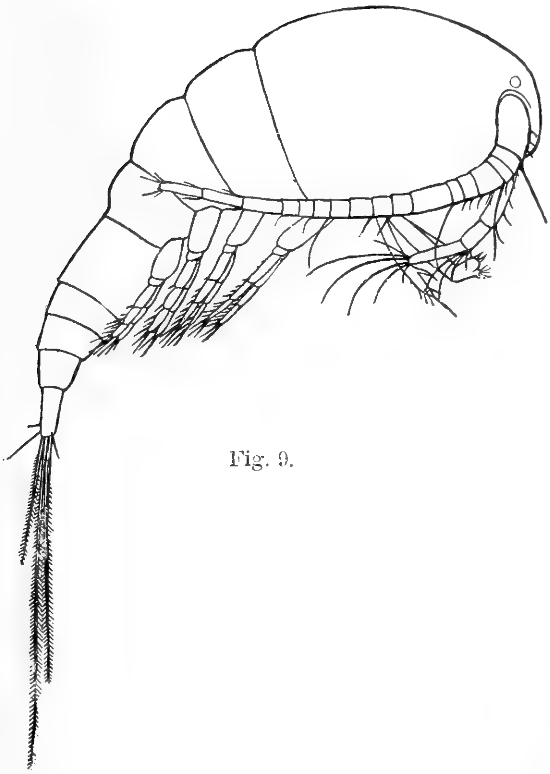

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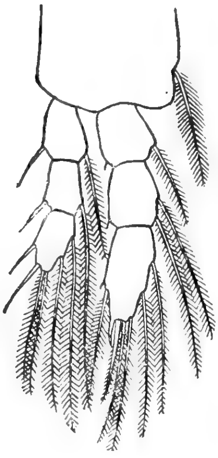

Fig. 10.

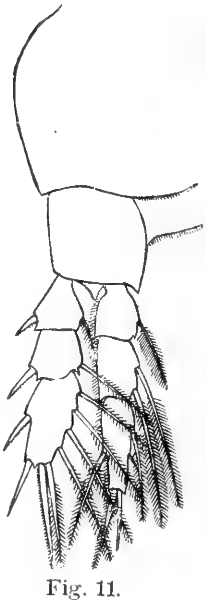

Fig. 11.

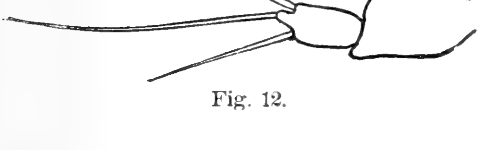

Fig. 12.

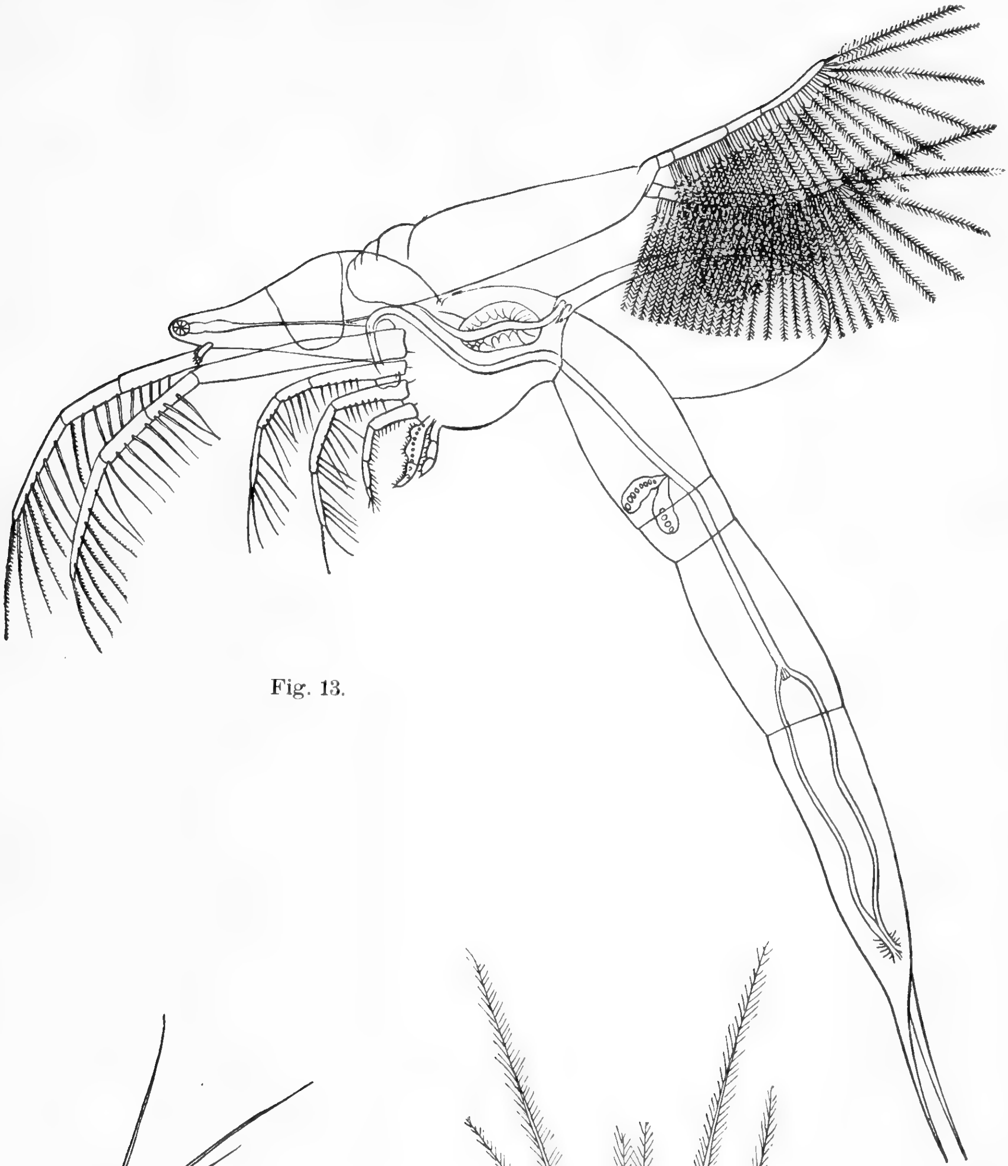

Fig. 13.

Fig. 14.

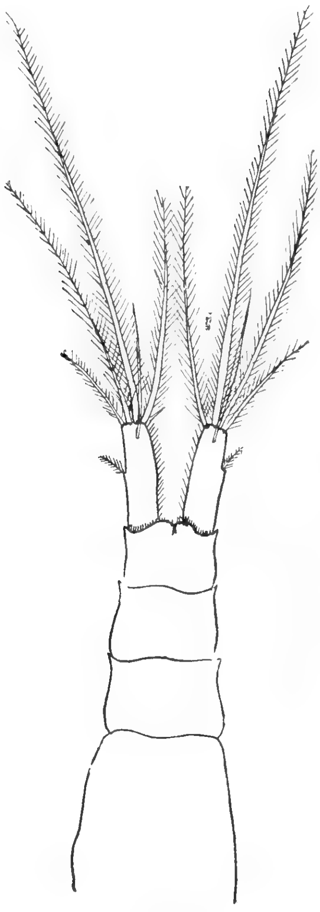

Fig. 15.

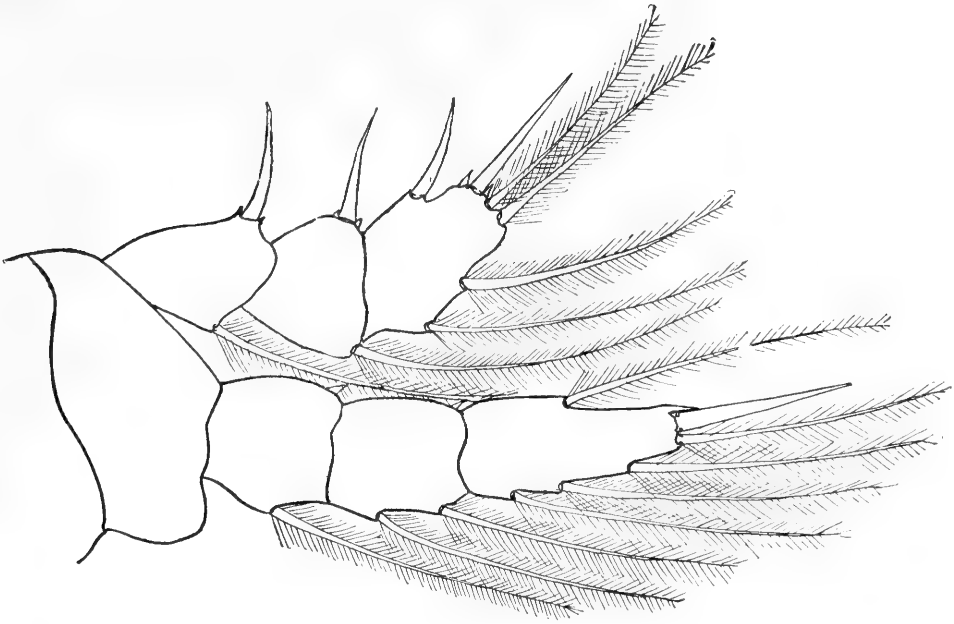

Fig. 16.

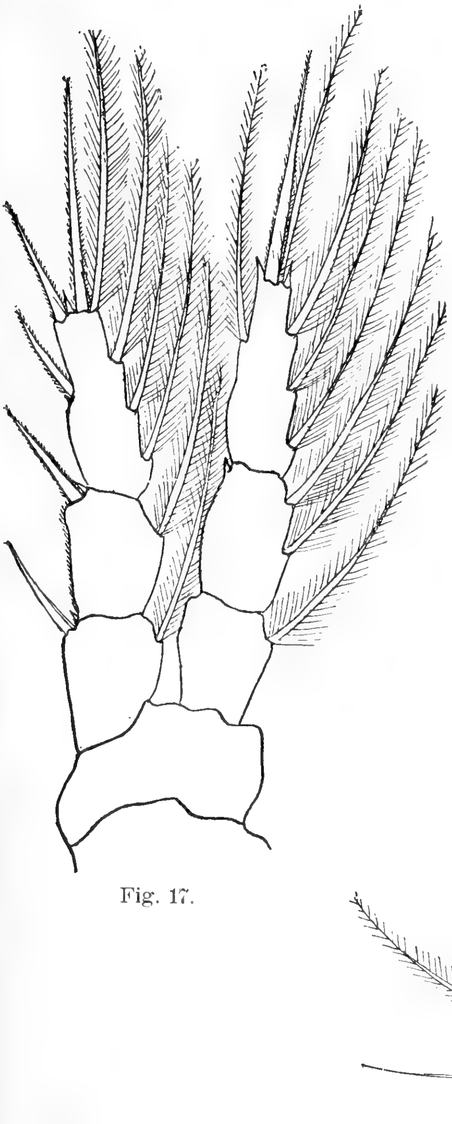

Fig. 17.

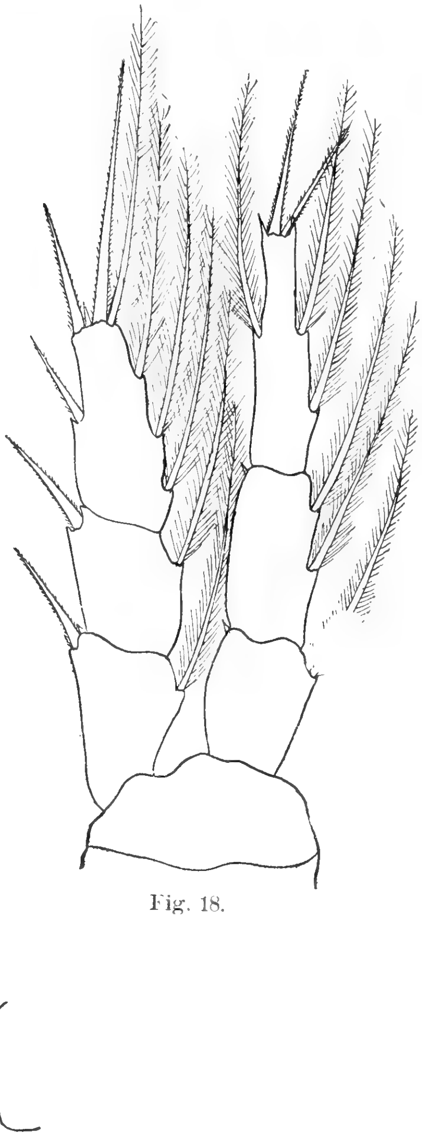

Fig. 18.

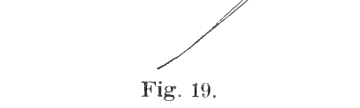

Fig. 19.

9.—NOTES ON ENTOZOA OF MARINE FISHES OF NEW ENGLAND, WITH DESCRIPTIONS OF SEVERAL NEW SPECIES.

PART II.

BY EDWIN LINTON.

The following paper contains notes on forty-two species of Cestod worms, eight of which were described in my former paper.*

After having had access to new material for study, with some added experience in the study of these difficult and often perplexing forms, I have been brought to somewhat different conclusions from those arrived at in my first paper. The changes in the nomenclature of the first paper are in brief as follows:

(1) *Phyllobothrium thysanocephalum* is referred to a new genus, and is recorded in this paper by the name *Thysanocephalum crispum* Lt.

(2) The species recorded as *Rhynchobothrium tenuicolle* Rudolphi I now regard as a different species. It is referred to a new species in this paper, and bears the name *Rhynchobothrium bulbifer.*

(3) *Rhynchobothrium bisulcatum* of my first paper was referred to the wrong genus. It is recorded in this paper as *Tetrarhynchus bisulcatum.* The reasons for the above changes will be found among the observations on the species.

Genera with regard to which there is some doubt are *Spongiobothrium, Anthocephalum, Orgymatobothrium,* and *Crossobothrium.*

There are peculiar difficulties in the way of classifying the unarmed *Tetrabothriidæ* and more investigation is needed in order to arrive at the truth. Further investigation upon fresh material may render it possible, as it is certainly desirable, to unite several genera of the *Tetrabothriidæ.*

It is with much reluctance that I have found myself obliged to add several new generic names, some of which, after further study of new material, may have to be relegated to the already spacious limbo of synonyms in this order. I find, however, that the descriptions which

* Notes on Entozoa of Marine Fishes of New England, with descriptions of several new species. Report of U. S. Fish Commissioner for 1886. Pp. 453–510. Plates I–VI.

have been most useful to me in the work of identification, are those which give many details of structure and are accompanied with illustrations. Whether the name given by the describer holds or not is a matter of secondary importance.

I have restored Van Beneden's genus *Acanthobothrium*, which had been combined with the genus *Calliobothrium* by Diesing. This necessitates an emendation of the definition of the latter genus. I have separated from the genus *Echeneibothrium* those species with echeneiform bothria, which are destitute of a myzorhynchus, and placed them in the new genus *Rhinebothrium*. Three genera, in which the bothria are united into a globe or disc were discovered, whose systematic relations are open to some debate. These have been named *Lecanicephalum*, *Tylocephalum*, and *Discocephalum*, respectively. The family name *Gamobothriidæ* is suggested for these forms, although I have thought best to put them provisionally with the *Tetrabothriidæ*. The species which I have described under the name *Paratænia medusia* has caused me much perplexity, to determine its relationship.

The specimens which are described in this paper were collected, for the most part, during the months of July and August 1886–'87, at Wood's Holl, Massachusetts. During the summer of 1887 I made most careful and painstaking search for small forms, and was eminently successful in my examination of the sting ray (*Trygon centrura*) and dusky shark (*Carcharias obscurus*). During these researches a variety of encysted forms were obtained. These were most abundant in the *Teleostei*. Several species of Trematods, Nematods, and Acanthocephala have been found. Descriptions of these will appear in due time. I have learned by experience that brief descriptions of these soft-bodied and variable forms are of but little use in identification, and have therefore endeavored to give such descriptions as will enable future investigators to identify the species accurately. It has been found that measurements, even of parts that are liable to great alteration on account of contraction, are invaluable as a means of identification. Measurements of hard parts, such as hooks, spines, and, to a certain extent, ova, are of course of the highest importance. Too much weight, however, should not be attached to absolute values where the differences are slight. Different methods of obtaining measurements, inaccuracies in computation, and individual errors must be allowed for. On the other hand, much weight must usually be given to relative dimensions, since in that case, several of the above-named sources of error are eliminated.

As far as it was possible to do so the specimens were studied while they were alive. Sketches of living forms were made by my wife while I was engaged in collecting, assorting, measuring, and recording observations on the specimens. I was thus enabled to collect much more data in the short time at my disposal than would have been possible without this assistance.

It may not be amiss to give here, for the benefit of collectors, the plan

which I adopted to keep track of my material and the notes and sketches made at the time of collecting. Since it was not desirable usually to attempt to identify the specimens in the short time during which they could be studied alive, especially, as was often the case, when my table was covered with a dozen or more dishes each containing a lot of specimens to be assorted, I found it convenient to keep what I may call a numerical check-list. In this check-list each capture is denoted by a number, while the different species or groups into which the lot was assorted are indicated by the letters of the alphabet. The check-list contains the date of capture, number of fish examined, and usually the number of specimens obtained. A few numbers quoted from the check-list itself will illustrate the method sufficiently.

190, August 6 (1887), Trematods, same as No. 179*b*, gills and stomach of *Echeneis remora;* stomach empty.

191*a*, August 6, Long red Nematods (viviparous), same as 184*a*, on viscera and under peritoneum of *Lobotes surinamensis.*

191*b*, Cysts and embryo *Rhynchobothria* from viscera, under peritoneum of same.

191*c*, Trematods, intestine of same, fifteen specimens, small.

191*d*, Two small Nematods, intestine of same.

192*a*, August 8, Rhynchobothria from stomach of *Trygon centrura;* one ray examined.

192*b*, *Phyllobothrium*, one specimen, from lower part of spiral intestine of same, same as No. 178*b*.

192*c*, *Acanthobothrium*, numerous, spiral intestine of same.

Labels with numbers and corresponding data from check-list were placed in the bottles or vials in which the specimens were preserved. When greatly pressed for time temporary labels with numbers only were placed with the specimens. These were replaced as soon as possible by labels containing all necessary data. In cases where the living specimens were studied notes were kept on small pieces of paper of uniform size. A small tablet of unruled paper $5\frac{3}{4}$ by $3\frac{3}{4}$ inches was found convenient for this purpose. Where several pages of notes were filled from the study of a single number, the pages were not only numbered, but each page was marked with the check-list number. The pages were then pinned together and placed in a large envelope, where they were kept in numerical order so that they could be referred to without delay. Sketches of living forms were made, sometimes with the notes, but usually on separate pieces of paper. A tablet of unruled writing paper, 9 by $5\frac{3}{4}$ inches, was found to be a convenient size for sketches. Every sketch was marked with the check-list number. The sketches were kept in a separate envelope, and arranged in numerical order.

With the specimens, notes, and sketches numbered and arranged according to a uniform system, it was scarcely possible for any mistake to occur in the way of referring a specimen to other than its proper host. It was also easy to collect duplicates into a group for study. In the winter months, whenever a half-day, or even less, was at my disposal it was possible to utilize the time in a way that could scarcely have been done if no special method of work had been pursued. As far as time and material would permit, specimens were prepared by stain-

ing and sectioning for anatomo-histological study. In final writing all notes were revised and their data incorporated in the description for publication.

I have not attempted to give complete synonymies, but have in each case given what seem to me to be the more important references. The older synonymy can be found in Diesing's classical work.

Under the formal heading "habitat," I have given only the host in which I have found the species. For new species this is complete, but it is, of course, incomplete for old species. In the latter cases I have alluded to the usual host or hosts in connection with remarks on the species.

So far as my investigations go, it would appear that very few of the cestod entozoa of fish pass their adult stage in different specific hosts. With regard to the encysted forms, however, the range of hosts appears to be greater.

The nomenclature of fishes used in this paper is that adopted by Prof. G. Brown Goode, in "The Fisheries and Fishery Industries of the United States, Section I, Washington, 1884." I desire to express here my sincere obligations to Mr. Vinal N. Edwards for his valuable assistance in providing material for study. It is but a poor acknowledgment of the valuable services rendered by my wife, Margaret B. Linton, in the preparation of this paper, to say that the illustrations which accompany it are the work of her hand.

ORDER CESTOIDEA.

Family I—PSEUDOPHYLLIDÆ *Van Beneden.*

Dibothriidæ Diesing.

DIBOTHRIUM Rudolphi.

Usage is about equally divided between the names *Dibothrium* and *Bothriocephalus* for this genus. Rudolphi used the name *Bothriocephalus* as a generic title, and divided the genus into two subgenera to which he gave the names *Tetrabothrium* and *Dibothrium*. The latter, as used by Rudolphi, had about the same limitations as it now has.

1. *Dibothrium restiforme*, sp. nov.

[*Restis*, a cord.]

[Plate I, Figs. 1-16.]

I have found it necessary to make a new specific name to accommodate four *Dibothria* from the intestine of the rare silver gar (*Tylosurus caribbæus*).

The head of the living worm is broad-oval, flat, two-lobed, the lobes longitudinally and somewhat radiately striated, rather squarish or

shouldered behind, and tapering to a blunt point in front. Two very deep fossæ which are marginal with respect to the head, lateral with reference to the body, divide the head into two leaf-like lobes, with thin flexible borders. When the edges of the lobes are closely appressed the fossæ appear as marginal slits. The fossæ extend to the apex of the head but do not unite. Each fossa is continuous behind the head with a narrow median furrow.

The body near the head is quite narrow, almost cylindrical, or a little flattened on the margin to correspond with the greater marginal diameter of the head. It is very much narrower than the head. The segments begin immediately behind the head, where they are short and thick and very much crowded. They increase in length slowly until about the posterior third where they are nearly square. The segments of the posterior third are nearly square and quite thin. The body is of nearly uniform breadth throughout its entire length.

Genital apertures lateral near middle of segment, male and female approximate. Aperture of oviduct on opposite lateral face of strobile near anterior edge.

Maximum length 765^{mm}; breadth of body 1.8^{mm}; breadth of head 2.5^{mm}.

Habitat.—Tylosurus caribbæus, intestine. Buzzard's Bay, Massachusetts, July 27, 1886. Four specimens.

Three of the specimens were very slender, almost filiform, the other was more contracted and consequently thicker, but it, too, was of nearly uniform size throughout.

The shortest specimen measured about 64^{mm} in length when lying undisturbed in water. When taken by the posterior end and lifted slowly from the water, allowing it to stretch out to its fullest extent by its own weight, it increased in length to 240^{mm}. The largest specimen, measured in the latter way, was 665^{mm} in length. After lying in sea-water for twenty-four hours it was again measured and found to be 765^{mm} in length. After being preserved twelve months in alcohol it still measures 720^{mm} in length. The other specimens while living measured 215 and 262^{mm} respectively.

The genital apertures are lateral; on the larger specimen the following points were made out with no other aid than a simple lens: On one of the lateral faces openings occur on the middle of the segments along the median line. These apertures were traced to within 160^{mm} of the head, where they merged into a median lateral groove; the latter is continuous with one of the marginal fossæ of the head; on the opposite lateral face there is a small opening or pore near the anterior edge of each segment; these pores are not usually exactly on the median line of the strobile, but stand a little to one side or the other and thus make an irregularly sinuous line; they were traced to within 240^{mm} of the head, where they become indistinguishable in the median groove; the latter, like its fellow on the opposite face, extends to the head, where it is continuous with the other marginal fossa of the head.

There is danger of some confusion in the use of the terms marginal and lateral in the description of this worm, arising from the fact that what one naturally calls the margin of the head is continuous with the lateral face of the body; in a brief description of the worm, therefore, one should say bothria lateral, if by bothria the deep fossæ are meant.

The posterior segments are slightly irregular; in one case two segments were fused into one and the last segment was somewhat distorted.

The following measurements were taken from the longest specimen after it had lain for some time in alcohol. Length of strobile 720^{mm}; length of head 4^{mm}; breadth of head at base 2^{mm}, middle 2.5^{mm}, apex 1^{mm}; thickness of head 1.5^{mm}; diameter of neck 1^{mm}. The diameter of the neck, or, more properly speaking, of the body immediately behind the head, is a trifle greater when measured in a line corresponding to the breadth of the head than it is on a line corresponding to the thickness of the head.

In the alcoholic specimens the shape of the body differs very little from that of the living worm. It still has the same uniformity of breadth throughout. There are, however, some differences in the head which are worthy of mention. The head of the alcoholic specimen is shorter, thicker, and more bluntly pointed than that of the living specimen. The apex of the head is almost truncate. The lips of the fossæ are more or less crimped and folded and the fossæ are somewhat gaping, while the broad lobes are deeply furrowed. These furrows are, in the main, longitudinal.

The median lateral furrows of the body are, in the alcoholic specimens, very strongly marked. Near the head each median furrow appears to turn to one side in order to meet the fossa of the head, in which it terminates. The true nature of this apparent twist in the anterior part of the body is made evident by transverse sections of the head and anterior segments as described further on. While in the living worm the anterior segments are very indistinct, in the alcoholic specimens they are tolerably distinct and can be traced almost to the head. Near the head they are about $.17^{mm}$ in length and 1^{mm} in breadth. At a distance of 15^{mm} from the head the length is $.22^{mm}$; breadth 1.2^{mm}; thickness $.84^{mm}$. Two hundred millimeters back of the head the segments are $.36^{mm}$ long, 1.8^{mm} broad and $.8^{mm}$ thick. At a distance of 330^{mm} from the head the segments are $.8^{mm}$ long, 1.8^{mm} broad and 6^{mm} thick. Near the posterior end of the longest specimen, the length of the segment is 1.9^{mm}, breadth 1.4^{mm}, thickness $.5^{mm}$.

After staining with carmine, transverse sections of the head were made in order to ascertain, if possible, the nature of the fossæ as compared with the cupping disks of such a species as *D. microcephalum*. The sections at the apex of the head prove the fossæ to be true bothria, Fig. 9. In these sections there is a nearly square central part measuring .22 and $.3^{mm}$ in its two diameters, with the crescent-shaped sections of the apices of the bothria lying at the two longer sides. In the

first half-dozen sections the bothria are distinct from the central part, of which they appear to be small auriculate appendages. The position of the bothria at this point is very plainly lateral. The bothria soon become fused with the central part and then lose their distinctive character, appearing simply as deep indentures on the sides of the head. Fig. 10. The diameter of the central core of the head, at the point where the bothria cease to be distinct, measured between the bottoms of the pits, is .26^{mm}. The diameter through the head at right angles to this is .49^{mm}. The breadth of the sections, including the edges of the bothria is .6^{mm}. The latter edges are induplicate, if straightened the breadth would be increased .2^{mm}. Proceeding towards the base of the head the sections are found to differ gradually the one from the other. The distance between the bottoms of the fossæ becomes shorter and shorter, until, at the point where the lobes of the head are widest, the pits are separated from each other by a mere thread .06 to .08^{mm} diameter, Fig. 13. The diameter of the head at right angles to the above, that is, in the direction which answers to the thickness of the head, is .74^{mm}. The diameter in the latter direction has increased from the apex to this point from .49^{mm} to .74^{mm}, while the opposite diameter, that is, the distance through the head from the bottom of one pit to the bottom of the other, has decreased, in the same distance, from .26^{mm} to .06^{mm}. The edges of the fossæ have, in the mean time, increased in length. In fact they no longer appear as lips of bothria, but rather as prolongations of borders of a bi-lobed head. The inner faces of these prolongations are smooth, as shown by the entire outline of the cross-section, while the outline of the outer faces is deeply crenulate on account of the longitudinal furrows there cut through. The thickness of these prolongations at base is about .32^{mm}; at the apex, that is, at the margin of a lip of the bothria, about .08^{mm}. The entire breadth of the head at this point, about the widest part, is, when the lobes are straight, in the neighborhood of 2.6^{mm}. Transverse sections, for the greater part of the length of the head, bear a close resemblance to the figure eight.

Towards the base of the head the central part widens quite rapidly. At first this widening is, for the most part, at the expense of the fossæ. For example, in a section where the greatest breadth of the head is 2^{mm}, the distance between the bottoms of the fossæ is .68^{mm}. A little further back the fossæ are represented by deep grooves, while the sections are nearly trapezoidal with crenulate outlines.

In the mean time the aquiferous vessels have made their appearance. A line joining the two main vessels, as seen in section, would be very nearly at right angles to a line joining the deep grooves, which represent the continuation of the fossæ. The sections were carried back of the head a short distance. In the last ones made, the deep emarginations at the ends of the section show the position of what further back on the body are the lateral grooves. The aquiferous vessels still occupy the same relative position with reference to these emarginations.

Since the aquiferous vessels occupy the same relative position with reference to the fossæ of the head as the grooves on the anterior part of the body, and, as is shown by sections of mature segments, with reference also to the lateral rows of pores and genital apertures, the fossæ are proved to be lateral. The apparent shifting of the grooves from the margins of the head to the lateral sides of the body already alluded to is, therefore, due to a simple twisting of the body behind the head. This twisting is a natural result of the flattening of the head in a plane which is at right angles to the plane of flattening of the body.

A longitudinal section through the head shows that the central part resembles the entire head of such species as *D. manubriforme* and *D. punctatum*, which have rather long and slender heads. The thin edges of the lobes of the head of this species, as indeed is plainly shown by sections near the apex of the head, are simply the prolonged lips of normal bothria.

With regard to the musculature, the longitudinal fibers are pretty uniformly distributed through the head—a little more abundant near the borders and at the center. No definite arrangement into fascicles was observed in the head. The transverse fibers are very fine and abundant, and cross each other in the most intricate fashion. Towards the base of the head the longitudinal muscle fibers predominate in the center. Behind the head they are arranged in fascicles. In longitudinal sections made a short distance back of the head these fascicles were beautifully shown. They appeared as rather large isolated bundles of slightly wavy longitudinal fibers.

The vessels of the water vascular system appear to branch irregularly through the lobes of the head, and are not collected into the principal channels until toward the base of the head. Immediately behind the head the cut ends of the two principal vessels are seen in section as narrow oblique apertures, .016 and .008^{mm} in the two diameters.

In respect to the disposition of the reproductive organs the results of my investigations thus far are not wholly satisfactory. The reproductive openings proper are situated along the median line of one of the lateral faces of the body and are about the middle of the length of the segment. The single large aperture, which, with its slightly raised border, can be seen easily with an ordinary lens, is the common opening for both the sexual organs of the segment. After two or three thin longitudinal sections have been made on the side of the segment which bears the reproductive opening, the vagina is brought into view lying immediately behind the opening of the cirrus and close to it. The male aperture quickly widens into the cirrus pouch, .08 to .1^{mm} in diameter, as the sections are carried towards the interior of the segment. The vagina remains of uniform size, about .016 to .021^{mm} in diameter. The cirrus pouch in transverse sections is oval. It extends to the middle of the interior of the segment, that is, the pouch is equal in length to about half the thickness of the segment. The cirrus was invaginated

in all cases, but was plainly seen as an irregularly convoluted tube lying within the pouch. The vagina follows the posterior edge of the latter as far as its base. I have not yet been able to determine its course beyond that point with any degree of certainty.

The interior of the unripe segments, when seen either in cross or longitudinal sections, appears for the greater part to be an open net-work of connective fibers, in the spaces of which are granular bodies, of which three different sets were made out. What I take to be the ovary is a lobed body, lying near the posterior edge of the segments, and symmetrically on each side of the median line. It lies nearest that lateral face which does not bear the sexual apertures. It is broader in its transverse than in its longitudinal diameter. In its widest part it equals about one-fourth the breadth of the segment, and in its thickest part it about equals one-fourth the thickness of the segment. Immediately above it a small oval body was observed in some of the transverse sections, which I take to be the shell-gland. In front of the ovary and occupying the middle of the interior of the segment there is a mass of granular globular bodies which are differentiated into two kinds by carmine. The more central ones remain yellowish in color while the others are deeply stained. The latter I take to be the testes, the former is probably the vas deferens.

The walls of the cirrus-bulb and of the vaginal tube are clearly defined and composed for the most part of circular fibers.

Near the anterior edge of each segment, and on the side opposite that which bears the reproductive apertures, is situated a circular aperture about .04^{mm} in diameter. It enlarges into an inner cavity which apparently communicates with some large irregular spaces that probably represent sections of the uterus. The wall of this aperture, as well as those of the inner cavity, with which it communicates, are rather thick and granular. On the mature segments these apertures persist and become larger, while those of the reproductive organs become rather indistinct. In the mature segments they were also seen to communicate with enlarged open spaces which, in the younger segments, contain granular masses. The mature segments are, to a great extent, filled with the ample folds of the uterus, which are crowded with ova. The uterus, and the ovary together in these segments, have the appearance of the letter S.

In the posterior part of the segment those folds of the uterus which are adjacent to the ovary are crowded together so as to form an irregularly lobed mass. In the middle of the segment the lobes are parallel with each other in a direction transverse to the axis of the segment, and, for the most part, one side of the median line. In front of this the uterus broadens and loses its lobed appearance, while the contained ova are not so densely crowded. This part of the uterus corresponds to the open cellular spaces observed in the sections. It is to be noticed that this part of the uterus, which lies in the anterior part of the seg-

ment, contains the mature ova, and is, furthermore, in the vicinity of the excretory pore, from which the ova evidently make their escape.

Upon examining a section through one of these mature segments, the ova are discovered to be yellowish, opaque, quite irregular in outline, without hard shells, or rather appearing as if the shells were soft and yielding and had collapsed. While there is much variety in the shape and size of these ova, the prevailing shape is oval and the dimensions about .033 and .018^{mm} in the two diameters.

None of the specimens in this lot were, strictly speaking, mature. At least the ova did not appear to be mature, and the folds of the uterus contained, in addition to veritable ova, slightly larger spherical or suboval masses. The latter, in specimens stained with carmine, consisted of a clear, pellucid, structureless membrane containing a granular mass, which was frequently deeply stained. There was no tendency whatever for the segments to become detached from each other.

2. *Dibothrium manubriforme* Lt.

[Report of Commissioner of Fish and Fisheries for 1886, Plate I, Figs. 1–4.]

In August, 1886, I had the opportunity of examining a sail-fish (*Histiophorus gladius*) taken off Newport, Rhode Island. I found but a single intestinal parasite, a *Dibothrium*, which I recognized at once, in spite of its mutilated condition, to be very near, if not identical with, my *D. manubriforme*, which was obtained the previous summer from a spear-fish (*Tetrapterus albidus*).

The head of the worm could not be found and the entire specimen was in bad condition, owing to the fact that decomposition had set in in the viscera of its host. The specimen was tranferred to alcohol, and the measurements which are given are therefore all from the alcoholic specimen. It is very considerably longer than the specimens obtained from *T. albidus*, but a careful comparison with those specimens convinces me that it is identical with *D. manubriforme.*

In order to obtain a more certain identification of this specimen, I made transverse and longitudinal sections of some of the median segments and compared them with corresponding sections made from one of the specimens from *T. albidus.* This investigation confirmed me in my view that the specimen in question should be referred to *D. manubriforme*, and also enabled me to add some additional data to the anatomy of that species.

The specimen from *H. gladius* affords the following measurements: Length, 220^{mm}; breadth in front about 1^{mm}; greatest breadth 5^{mm}, at a point 70^{mm} from the posterior end; breadth at posterior end 2^{mm}, where it terminates in a bluntly rounded point. The body is about 1.5^{mm} thick at the thickest point. The worm is therefore rather slender, but this habit might be very much changed by contraction. The difference in length between this specimen and those from *T. albidus*, the

longest of which measured 140^{mm}, becomes less significant when it is remembered that the former when found was practically dead and consequently there was little or no contraction of its tissues when it was transferred to water and to alcohol. The tissues of the other specimens were living and were therefore liable to contract when placed in water after removal from their host, or when first disturbed in their resting place.

The posterior third of the body of the specimen from *H. gladius*, as in those from *T. albidus*, is marked by a dark brown median stripe made by the ripe ova in the crowded ovaries. A median furrow on one of the lateral faces of the body begins towards the anterior and becomes punctate towards the posterior region, where the minute lateral genital apertures become visible in a zig-zag row. The margins of the strobile are apparently entire. The segments are very short, with their posterior edges slightly wavy on the median segments, thus suggesting those of *D. plicatum.* The posterior edges of the median segments are crowded together like the edges of the leaves of a book about .2^{mm} apart. Near the posterior end they are not so closely crowded, being about .4^{mm} apart. The anterior part had undergone decomposition to such an extent that it was reduced to a mere filamentary shred which gave no sign of the presence of either bothria or segments.

The ova in this specimen are identical with those in the other lot. They present also the same features noted in the case of the others; that is there seem to be two sorts, one yellowish in mounted specimens, with a strong shell, in some cases white and opaque; another sort transparent, with a very thin shell. The latter, in specimens stained with carmine, have a granular contents which is colored by the staining fluid. They are entire in outline, oval, length as much as .05^{mm}, shorter diameter .03^{mm}. These measurements were obtained from both lots. Transparent yellowish ova were found which were usually collapsed on one side, thus being bowl-shaped. They measured .054^{mm} and .027^{mm} in their two diameters. The diameters of ova given in my original description of this species are .045^{mm} and .03^{mm}. These dimensions may be taken as average.

Anatomy.—Transverse sections, made through that part of the body which is immediately in front of the segments that contain ripe ova, show that the body is made up of a series of concentric layers of muscular tissue surrounding a flat core. Next to the thin cuticle is a thick granular layer in which lie radiating, longitudinal, and circular fibers. Of these the circular fibers are the finest. They appear, indeed, as delicate hair-like lines under an enlargement of 600 diameters.

The granules in the outer layer in longitudinal sections, stained with carmine, in many places appear as clusters or nests of nuclei. Towards the posterior end of each segment the circular fibers become more numerous about the middle of the outer concentric layer, and presently the

layer is differentiated into two distinct layers. The outer of these layers is finely granular, and contains very few longitudinal fibers. In it the radiating and circular fibers predominate. The inner layer, on the other hand, is coarsely granular, and contains a considerable number of longitudinal fibers. The outer of these two layers soon separates from the other along the line of fine circular fibers to form the projecting posterior edge of the segment. Next within the granulo-muscular layer is a thin layer of circular fibers, and within this again a thick layer of longitudinal fibers. The latter are very large, although not at this point in distinct fasciculi. Farther back towards the posterior end they become fascicled. The connective tissue in this layer appears finely granular in transverse sections, while in longitudinal sections it appears as a network of delicate fibers which fills up all the interstices between the longitudinal fibers. The longitudinal fibers of the inner part of the granular layer do not differ essentially from those of the longitudinal muscle layer proper, except that they are more scattered, while their interstices are filled with connective tissue in which are numbers of both coarse and fine granules, highly colored in carmine-stained sections. The longitudinal muscular fibers in general do not lie parallel with each other. They form, indeed, a maze of interlacing and apparently anastomosing fibers whose general direction is longitudinal. The diameter of the largest single longitudinal fibers in the granular layer is about .004^{mm}, and, in the longitudinal muscle layer proper, twice as much. The longitudinal muscle layer is separated from the inner core of the segment by a thin layer of circular fibers. It is, moreover, interrupted at the margins where it is penetrated by the margins of the inner core. The latter is fusiform in transverse section, and contains the reproductive organs. It is crossed by numerous fine transverse connective fibers, and extends nearly to the margins of the segment, where it appears to be continuous with the inner granular layer. It is quite narrow except in ripe segments, where the center becomes very much enlarged on account of the presence of the numerous ova. The central mass of ova enlarges at the expense of the longitudinal muscle layer. The walls of the segment are also bulged outward by the mass of ova.

The reproductive apertures are near the median line on one of the lateral sides. They are very close together and rather small. Each aperture represents a pair of sexual organs, cirrus and vagina. Upon making a few longitudinal sections on the lateral face which bears the reproductive apertures, the small vaginal opening comes into view. It opens into the common aperture from behind and near the surface. The larger aperture continues into the cirrus-bulb, which has thick muscular walls composed of circular fibers. The cirrus was retracted in all cases. It is about .008^{mm} in diameter. The bulb is rather long and descends into the segment vertically nearly to the middle. The relative position of the various organs was not ascertained with entire satisfaction. The vagina, however, lies close to the posterior side of the

cirrus-bulb and communicates with the ovary. The latter organ is centrally placed and lies next the inner side of the lateral muscular wall on the side opposite the genital aperture.

The testes are represented by granular masses in the marginal parts of the inner core.

The following measurements will assist to an understanding of the proportions and arrangements of the various muscular layers of the body: thickness of inner core at center .16^{mm}; near margin .08^{mm}; thickness of longitudinal muscle layer .2^{mm}; thickness of inner granular layer .12^{mm}; thickness of outer granular layer .16^{mm}. The layers of circular fibers are very thin, averaging about .01^{mm} in thickness. Breadth of inner core, margin to margin, 3.6^{mm}; breadth of segment 4^{mm}.

Longitudinal sections were carried through several contiguous segments. In these there were no septa to indicate a division of the body into true segments. The only indication of a segmented condition is the superficial character of projecting posterior edges. The longitudinal muscles are continuous and the ovaries are crowded together so as to form an almost unbroken zig-zag line. So far as any internal characters go, the body is practically continuous.

The above observations were made on sections lightly stained with ammonia carmine. The sections used in the description are from one of the specimens from *Tetrapterus albidus.*

Habitat.—Tetrapterus albidus, intestine, young and adult, July, 1885; *Histiophorus gladius*, intestine, adult; August, 1886. Off Newport, Rhode Island.

3. *Dibothrium punctatum* Rudolphi.

[Plate II, Figs. 1–4.]

Bothriocephalus punctatus Rudolphi, Entozoa Hist., III, 50, and Synopsis, 138 and 475. Leuckart, Zool. Bruchst., 40 and 64, Pl. I, 40. Drummond, Charlesworth's Mag. of Nat. Hist., II, 574. Eschricht, Isis 1839, 344, and in Nov. Act. Nat. Cur. I, XX, Suppl. II, 77 and 59, Pl. III, 17–18. Dujardin, Hist. Nat. des Helm., 617. Bellingham, Ann. Nat. Hist., XIV, 254. Van Beneden, Bull. Acad. Belgique, XVI, II, 278, and in Mem. Acad. Belgique, XXV, 161, Pl. XXI. Spencer Cobbold, Trans. Linn. Soc., XXII, 157. Olsson, Lunds Univ. Arsskrift, IV, 11. Von Linstow, Compend. Helm., 237.

Dibothrium punctatum Rudolphi, Diesing, Syst. Helm., I, 593; Sitzungsb., XIII, 579; Revis. der Ceph. Ab. Par., 240. Leidy, Proceed. Acad. Phila., VII, 444, and VIII, 46. Molin, Denksch. d. kais. Akad, XIX, 235.

For additional bibliography, etc., see Diesing's Syst. Helm. and Revisions.

Diesing's description of this species is as follows: Head oblong, rather broad, with oblong lateral bothria. Neck none. First segments elongated, subsequent segments subquadrate. Genital apertures opposite on the lateral face of each segment. Length, 300 to 450^{mm}.

This species has been very fully described by Mueller, Rudolphi, and others. It is said to be an abundant species in various fishes of

Europe, *Cottus*, *Scorpius*, *Gadus*, *Pleuronectes*, *Trigla*, *Rhombus*, etc. Eleven species of European fish are enumerated by Diesing as harboring this parasite. It has been recorded in this country by Dr. Leidy in *Platessa plana* (*Pseudopleuronectes americanus*).

I refer to this species two lots of Dibothria obtained from the intestines of the spotted sand flounder (*Lophopsetta maculata*) and the sand dab (*Limanda ferruginea*). The first lot containing one complete specimen and a few fragments of others, with a few cestoid cysts from the peritoneum, was the sole result of an examination of seven flounders. In the second lot about a dozen fish were examined, nearly all of which were infested with an echinorhynchus (*E. acus*). These fish were taken with the trawl by the U. S. Fish Commission steamer *Fish Hawk*, south of Martha's Vineyard, Massachusetts, in about 12 fathoms of water. Their stomachs contained several species of Annelids, fragments of *Squilla*, and several specimens of a species of *Margarita*.

The sketches of the living worm (Figs. 1 and 2) were made from the specimen obtained from *L. maculata*. Its dimensions while living were as follows:

	Millimeters.
Length	200.00
Length of head	2.40
Breadth of head at apex	0.24
Breadth of head, middle	0.42
Breadth of head, base	0.22
Breadth of first segment at anterior margin	0.20
Breadth of first segment at posterior margin	0.24
Length of first segment	0.36
Breadth of one of posterior segments	2.60
Length of same	1.20

Associated with this specimen, and doubtless belonging to it, was a chain of mature segments, each of which was about 2.1^{mm} in length and 1^{mm} in breadth.

The head of the living worm showed little tendency to change its shape. It maintained constantly the proportions shown in Figs. 1, 2.

It is rather flat, broadest in the middle, and tapers uniformly with convex margins toward each end. It is terminated in front by a slightly tumid apex. The base of the head continues in a short neck-like part, which has a projecting border on the posterior edge like that of the segments. The marginal pits are quite deep. In front they extend to the tumid apicular part. They terminate behind at about the posterior fourth or fifth of the entire length of the head, leaving a short, constricted neck-like part.

The only motion observed was a slow change in the edges of the bothria, which at times were nearly parallel and at others were profoundly crenulated. In active specimens they are evidently capable of assuming very various shapes.

After having been preserved in alcohol the head is of nearly uniform breadth throughout. It is slender and arcuate, measuring 1.8^{mm} in

length, and 0.16^{mm} in breadth at the apex, increasing to 0.2^{mm} in the widest part. The length of the first segment is 0.28^{mm}, its breadth in front 0.11^{mm}, behind 0.15^{mm}. The anterior segments for about 16^{mm} back of the head are quite slender. The body, indeed, for this distance is decidedly filiform, and for that reason it is very difficult to determine whether the bothria are to be regarded as marginal or lateral with reference to the body. Secondary segments appear at about the twelfth segment from the head. These are formed by a division of each segment into two by means of a median transverse line. This is repeated farther back in much the same manner as described under *D. microcephalum.* This evidently explains the phenomenon which the posterior segments present of being welded together in groups of three or four, an appearance which is quite characteristic of the posterior segments and which has been alluded to in various descriptions of this species. The posterior segments are squarish, with the posterior edge of each slightly overlapping the following segments, and thus giving to the strobile a serrate margin.

About 40^{mm} from the head the reproductive organs become visible. In a specimen rendered partially transparent with glycerine they appear as a median row of white opaque masses 0.2^{mm} long and 0.06^{mm} broad, lying transverse to the longitudinal axis of the worm, parallel to each other and very close together. The apertures of the reproductive organs are lateral, all on one side, and may be seen following the median line as a row of small elevated papillæ. In the middle of the strobile there sometimes appear to be as many as four or more papillæ to a single segment. These compound or fused segments probably divide into simple segments as they mature. Toward the posterior end of the strobile, along with and on the reproductive papillæ, are clusters of ova which have been extruded from the ripe segments. The ova are yellowish-brown in color. On this account the median segments have a median band, which is equal in breadth to about one-third the breadth of the segment, and which is rusty yellow, or yellowish-brown, or in alcohol almost black. On either side of this median band the segments are punctate with brownish spots. Upon the opposite lateral face of the strobile also small bunches of ova were seen, which had been extruded from minute pores in the vicinity of the median line.

The ova are rather large, elliptical or long oval in outline; length, 0.058^{mm}; shorter diameter, 0.027^{mm}.

The vessels of the water vascular system are quite distinct in a specimen which has been placed in glycerine.

The two specimens from *Limanda ferruginea* have, in alcohol, the following dimensions:

	No. 1.	No. 2.
	Mm.	*Mm.*
Length	98.00	75.00
Length of head	1.60	3.20
Breadth of head at apex	.40	.40
Breadth of head, middle	.50	.48
Breadth of head, base	.50	.60
Length of first segment	.18	.16
Breadth of first segment	.48	.50
Length of posterior segment	1.00	.80
Breadth of posterior segment	2.00	2.50
Greatest breadth of body	3.50	2.75

The appearance of these specimens, especially with respect to the head and anterior segments, is quite different from that of the specimen from *Lophopsetta maculata.* Moreover, the heads of these two specimens differ with respect to each other. I do not, however, recognize any difference, either in proportions or in special characteristics, that can not be explained as due to different states of contraction. The heads of these latter specimens are arcuate, a condition which is plainly the result of unequal lateral contraction of the longitudinal muscles; they are blunt at the apex with slightly tumid edges, as in the first specimen. The fossæ are plainly lateral. This feature was uncertain in the first specimen, but in these it is quite evident on account of the highly contracted and consequently flattened condition of the anterior segments.

Although the head of one of these specimens is twice the length of the other, there can be no doubt that the specimens are specifically the same. The shorter head is of nearly uniform size throughout, averaging about .5^{mm} in diameter. It is crossed by exceedingly fine transverse wrinkles, most abundant at the base. These are evidently the result of contraction. The longer head is more slender for the greater part of its length than the other, but thicker at the base. It is, as a whole, somewhat cuneiform in shape.

When these specimens were placed in glycerine, with a little acetic acid added, the central axis of the head was brought into view. This is seen to be abruptly constricted behind the capitate apex, swollen immediately behind the constriction and again at the base of the head, while in the middle of the head it is slender.

The fossæ, which are marginal with respect to the head but lateral with respect to the body, are profound, and extend in one nearly, in the other quite to the base of the head.

The segments begin immediately behind the head and are at first more than twice as broad as long. In this feature they are quite dif-

ferent from the first specimen. They differ also from most descriptions of this species. The segments in question have, however, every appearance of being much contracted. Fine transverse lines appear on the faces, while the margins are wrinkled; the segments themselves are quite thick and stout. A short distance back of the head the segments are alternately shorter and longer, as noted in the first specimen, while toward the posterior end of the body the adult segments are arranged in groups of from four to six simple segments, as if the latter were partially fused together, which is another characteristic of this species.

The ova have the same dimensions as in the first specimen, and are collected in oval or oblong masses. Here and there a mass occurs whose size far surpasses those of adjoining segments, and which causes the walls of the containing segment to bulge out into a prominent lateral lump. This feature was also observed in the first specimen.

The external openings of the oviducts are on one side in the shape of a row of lateral pores along the median line. The reproductive apertures are on the opposite side. Of these, but one, the male, could be certainly made out in the specimen when examined entire in glycerine. In nearly every case the cirrus was protruded. It is short, conical, and stands about the middle of the segment on the median line. It was difficult to get exact measurements of the length. The following dimensions, which were obtained by turning the strobile on edge and measuring the cirrus in outline, are nearly correct: Length, .1^{mm}; breadth at base, .04^{mm}; breadth at apex, .026^{mm}. When retracted it becomes a very short papillæ. Upon examining a few segments in glycerine, with an enlargement of some three hundred diameters, I noticed that there were two ducts leading to the common opening. One of these was continuous with the protruded cirrus. The other led to a point behind the cirrus and at its base. I am inclined to believe from this that both reproductive organs have a common cloacal opening about the middle of the segment and on the median line. If this is the correct view, the vagina is quite small and opens immediately behind the cirrus. This differs materially from Van Beneden's figures of this species.

I have had some hesitation with regard to referring these specimens to *D. punctatum*, principally on account of its small size.

Drummond, however, in his "Notices of Irish Entozoa" (Charlsworth's Mag. Vol. II, p. 574) speaks of this worm as follows:

> I have found it largest in the brett, exceeding even 3 feet in length and as many lines in breadth; in the *cottus* I have found it 2 lines broad, and from 12 to 18 inches long, but in the turbot, so far as my observation has yet gone, it is seldom more than a line broad, and varies in length from 8 to 18 inches.

Since the hosts in which my specimens were found are closely related to the turbot of the other side of the Atlantic, it is of interest to note that the size of these Dibothria corresponds, in the main, with that of those which Drummond has found in the turbot.

Habitat—Lophopsetta maculata, August 10, 1887, *Limanda ferruginea*, September 6, 1887, Wood's Holl, Massachusetts.

4. *Dibothrium microcephalum*, Rudolphi.

[Plate II, Figs. 5–18.]

Tænia tetraodontis molæ, Viborg, Ind. Mus. Vet. Hafn., 241; Rudolphi, Entoz. Hist. III, 213.
Bothriocephalus microcephalus, Rudolphi, Synops., 138 and 473; Drummond, Charlsworth's Mag. Nat. Hist., IV, 241; Dujardin, Hist. Nat. des Helm., 619; Bellingham, Ann. Nat. Hist., XIV, 253; Von Linstow, Compend., der Helm., 274; Olsson, Lund's Univ. Årssk., III, 55, and IV, 11; Van Beneden, Mem. Acad., Belgique, XXXVIII, 87.
Bothriocephalus sagittatus, Leuckart, Zool. Bruchst., 39, Pl. I, 15.
Dibothrium microcephalum, Rudolphi, Diesing Syst. Helm., I, 592; Sitzungsb., d. kais. Akad., XIII, 578; Revis. d. Ceph, par., 241; Wagener, Nov. Act. Nat. Cur., XXIV, Suppl. 16, 69, Pl, VII, 77; Van Beneden. Bull. Acad., Belgique XXII, II, 521.

Head, sagittate in marginal, oblong in lateral, view, with a rounded button-like apex. Bothria lateral oblong, neck none, anterior part of body slender subcylindrical, median and postero-median part broader and thicker, narrower towards posterior. Body cylindrical or subquadrate in front and rather thick throughout. First segments somewhat funnel-form, subsequently becoming very short and broad, posterior segments short and narrow, squarish or sometimes indistinct.

Genital apertures marginal. Length in alcoholic specimens as much as 660^{mm}, greatest breadth 7.5^{mm}.

A lot of Dibothria containing thirteen individuals from the intestine of a sunfish (*Mola rotunda*) was collected by the U. S. Fish Commission off Martha's Vineyard, Massachusetts, September 10, 1886, and sent to me after my return from the laboratory at Wood's Holl, Massachusetts. I have therefore not had the opportunity of studying these parasites while they were living. All the data for this description were derived from the study of alcoholic specimens.

I have experienced much difficulty in reconciling differences between my specimens and previous descriptions. While I have little doubt but that the specimens in question are specifically identical with those figured by Wagener and Leuckart, there remains yet much to be desired in the way of a detailed description of the animal.

Among the thirteen specimens, all of which were adult and approximately of the same size, there was one which differed from the others in having an extremely small head and smaller and narrower anterior segments. The head had but little more than half the linear dimensions of the others, while the anterior segments were longer by nearly a third, and less than half as wide. The bothria, moreover, extended but a little way back over the first segment, while in the others they over-lapped the first two segments. The general outline of the head remains in other respects much the same for the two varieties.

These differences can not be accounted for by supposing different states of contraction, although it is true that contraction can and does give rise to differences in shape as well as in size. In this case, however, the differences are so profound, and, what is of still greater importance, so abrupt, there being no gradation by intermediate forms. I have felt myself obliged to recognize it by establishing two varieties. The specimen with the smaller head and narrower anterior segments I shall denote as variety α, the other as variety β. One might indeed be justified in separating them yet further and calling them distinct species if the same sharp distinction is observed in other collections. In that case variety α should retain the name *D. microcephalum*, and variety β should be referred to Leuckart's *D. sagittatum*.

Both Leuckart and Rudolphi mention the occurrence of individuals, some of which had relatively large, others relatively small heads. In the specimens which these observers examined, however, this difference could be accounted for apparently by a difference in the age of the specimens. The younger and immature individuals had relatively larger heads and longer anterior segments than the more mature specimens possessed.

I have recorded a similar difference in a lot of Dibothria from the file-fish (*Alutera schœpfii*) (U. S. Fish Commission Report, 1886, pp. 458, 459, Pl. I, Figs. 5–8). In that case both varieties were equally immature. In the present instance both varieties are equally mature.

While there is, therefore, almost sufficient grounds for establishing a new species, or rather for separating the present species into two and restoring Leuckart's species, which has been united with *D. microcephalum*, I shall for the present be content with referring both kinds to *D. microcephalum*, but shall distinguish the kinds as var. α and var. β, respectively. Wagener's figure, which is sketched from a young specimen and gives a lateral view of the head and first segments, bears a very close resemblance to var. α. Leuckart's figure also represents a lateral view of the head and anterior segments. It bears little resemblance to either variety, but resembles var. β more than it does var. α. In it the head is represented as being bluntly rounded in front, while in all the specimens in the lot upon which this account is based there is a constriction near the anterior end which produces a blunt button-like apex. The head in lateral view is therefore oblong and not sagittate, as in Leuckart's figure.

The terms marginal and lateral as applied to the head in this description designate those sides which correspond to the marginal and lateral sides of the body, respectively, although this use of the terms gives rise to the anomaly that the marginal diameter of the head is greater than the lateral.

A comparison of Fig. 6 with Fig. 9 might lead one to infer that there is a great difference between the two varieties with respect to the appearance of segments at the posterior end. While this is true in many

cases it does not represent a necessary condition of things. Some of the individuals of var. β showed the same indistinctness with regard to the occurrence of segments at the posterior end as is shown in Fig. 6 of var. α. Indeed, as will be shown further on, the segmentation in this worm is more apparent than real.

In the following detailed description I have not attempted to keep the varieties separate. The varieties themselves have been sufficiently defined in the foregoing and in the figures.

The head is small, sagittate in a marginal view, oblong in a lateral view. Near the anterior end is a constriction. The part in front of this constriction is short, projecting in a thick lip with rounded edges and bluntly rounded in front, nearly circular or somewhat quadrangular when viewed in front, but usually with a slight lateral emargination corresponding to the faces of the bothria. The latter organs are two in number, lateral, oblong, rather deeply hollowed out in the center with moderately thin edges, free and slightly flaring at the posterior ends. In most of the specimens of this lot the edges of the bothria are irregularly crimped or crenulate. A cross-section of the head shows that the edges of the bothria are thin, so that a section made transversely through the middle of the head resembles two crescents with their convexities truncated and then applied to each other. The bothria in most of the individuals (var. β) extend to or beyond the posterior edge of the first segment. In one it reached quite to the posterior edge of the second segment. There is no neck. The central core of the head becomes gradually thicker and broader until it merges into the first segment. A series of transverse sections carried on into the second segment shows the outer tissues sloughing off until a concentric ring is formed which indicates the posterior part of the first segment where it overlaps the anterior part of the second.

The anterior part of the body is rather slender, and slightly flattened, usually linear for a distance of 30 to 40^{mm}, then increasing in breadth uniformly until the greatest breadth is attained, which is about the middle of the total length. This breadth is maintained until near the posterior end where the body becomes distinctly narrower. In some the posterior end tapers to a blunt point. This is notably the case in var. α. One specimen, No. 4 of table, p. 350, measuring 610^{mm}, was linear for the first 50^{mm}. In the next 75^{mm} it increased in breadth gradually to 3.5^{mm}; 60^{mm} farther on it had increased in breadth to 6^{mm}. This breadth it maintained within varying limits to near the posterior end. In var. α the breadth of the first part of the body increases slowly but uniformly. At a distance of 25 or 30^{mm} it is 1^{mm} broad; 45^{mm} from the head it is 2.5^{mm} broad; 100^{mm} from the head 5.5^{mm} broad.

The segments which immediately follow the head are decidedly funnelform, the large posterior edge of each inclosing the narrow anterior end of its successor. These in some cases are followed, in the anterior part of the body, by segments with parallel lateral margins, and with the

posterior edge thin and flaring outwards at nearly a right angle. Sooner or later, however, these segments are crossed by transverse rugæ, which give rise in turn apparently to secondary and tertiary segments until, in the widest part of the body, the segments or pseudo-segments become so crowded together as to resemble transverse wrinkles.

The following details with regard to the feature just alluded to, although taken from var. α, do not differ materially from what is shown by var. β.

About the fifty-second segment, which, in this individual is 20^{mm} from the head, a median transverse line makes its appearance, which becomes more strongly marked on the next, and on the next yet more pronounced. The fourth primary segment following the fifty-second was plainly divided into two secondary segments, the posterior segment of this pair being the larger. Beyond this point the segments are alternately larger and smaller, until about the seventy-eighth segment where the same phenomenon is repeated, the secondary being divided into incipient tertiary segments, the transverse lines become more distinct, and about the eighty-second segment give rise to distinct tertiary segments. At a distance of 56^{mm} from the head the primary segments can still be distinguished by their more prominent projecting posterior edges. The latter are at this point about 1.25^{mm} apart. Between them are six segments which are alternately larger and smaller. The primary segments can be traced for at least 200^{mm} from the head. Beyond that point no difference could be discerned, all the segments having become very much crowded and rugæform.

In another individual the secondary segments begin about the forty-fifth from the head, and the tertiary about the sixty-fifth. The distinctive features of the primary segments are quickly lost.

In No. 4 of the table the forty-sixth and forty-seventh segments are divided into secondary segments, but no further indication of secondary segments is visible until the sixty-third. Tertiary segments begin about the eighty-fifth segment, or 65^{mm} from the head.

Another specimen, No. 5 of table, is somewhat narrower in habit than the others, and presents more irregularity in the formation of secondary and other segments. The third and fourth segments are welded together. Between the fifth and sixth, sixth and seventh, seventh and eighth segments is a single secondary segment. Each of the next three primaries bears two secondaries. On each of the next two primaries there are three secondaries. On each of the four following primaries there are five secondaries. These may be better described as primary segments of two sizes. There is no indication that the smaller are derived from the larger, and these irregularities may be due possibly to differences of contraction. Secondary segments like those observed in the other specimens occur about the ninetieth segment, a distance of some 40^{mm} from the head. In this individual the greatest breadth is 4.5^{mm}; breadth at posterior end 1.4^{mm}; length of posterior segments about $.65^{mm}$.

In many of these specimens the segments become rather indistinct near the posterior end on account of transverse wrinkles on the segments which resemble the dividing line between two segments. In No. 4 the segments 12^{mm} from the posterior end are 3.5^{mm} wide and $.5^{mm}$ long. The last but one measures 1^{mm} in length and 1.8^{mm} in breadth at the front end, narrowing to 1.2^{mm} at the posterior end. The last segment is 1.4^{mm} broad and 1.25^{mm} long, tapering to a bluntly rounded point.

The following measurements are introduced for the purpose of furnishing a basis of comparison between the two varieties. It will be observed that No. 1 differs uniformly in its head dimensions from the others, between which there are but few differences. No. 1 is var. α, the others are var. β.

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
Length	655.00	470.00	534.00	610.00	660.00
Length of bothria	0.86	1.54	1.60	1.54	1.80
Breadth of head, anterior, marginal	0.44	0.74	0.80	0.76	0.78
Breadth of head, anterior, lateral	0.48	0.80	0.80	0.74	0.78
Breadth of head, posterior, marginal	0.70	1.36	1.34	1.40	1.46
Breadth of head, posterior, lateral	0.54	0.84	0.80	0.76	0.80
Breadth of first segment, anterior, marginal	0.18	0.40	0.68	0.50	0.66
Breadth of first segment, anterior, lateral	0.50	0.90	0.90	0.80	0.90
Breadth of first segment, posterior, marginal	0.50	0.80	1.06	0.76	1.08
Breadth of first segment, posterior, lateral	0.56	1.24	1.26	1.22	1.42
Length of first segment	0.26	0.30	0.34	0.36	0.32

Some of the measurements in numbers 2 to 5 marked first segment were really taken from the second segment, on account of the anterior part of the first segment being obscured by the overlapping bothria. The difference between the first and second segments is, however, in all cases very slight.

In variety α one of the lateral faces is marked by two distinct linear grooves, parallel with the margins, each about 1.5^{mm} from the nearest margin. These are not distinct until about 125^{mm} back of the head; are most distinct in the middle of the body, but continue to the posterior end. Similar lines occur on the opposite face, but they are very faint. They probably outline the water vascular canals. They were not seen in the other specimens.

The presence of ova is indicated in the alcoholic specimens by a dark median line which, in var. α, begins 135^{mm} back of the head, and continues to within 6^{mm} of the posterior end. In the other specimens the ova begin at about the same point. In some (Fig. 9) the ova continue to the last segment, and the posterior segments are rather distinct. In one individual of var. β there is the same kind of termination to the body as in var. α. Several of the specimens had been mutilated in collect-

ing, so that it was not possible to determine the normal condition of the posterior segments.

The ova are amber colored, oval, .07 and .04^{mm} in the two diameters. They are usually collapsed on one side into a bowl-shape. They are observed in some cases lying in small clusters and making a zigzag line on one of the lateral faces of the strobile. The masses of ova within the strobile do not seem to coincide with the segment, but, as they develop, push into the adjoining segments, so that the median line of ova is an almost continuous one.

The cirrus is long, slender, marginal, irregularly alternate, and protrudes from the middle part of the margin of a segment.

The cirrus bulb is pyriform, and lies with its larger end towards the middle of the body. It is directed a little posteriorly, and extends a little beyond the marginal vessel of the water vascular system. The longest cirrus observed measured 1^{mm} in length, and was .04^{mm} in diameter at base, and .02^{mm} in diameter at the apex. The segments are deeply wrinkled at the marginal genital aperture, the wrinkle extending about one-third way to the median lateral line.

The marginal vessels of the water vascular system can be easily traced when the specimens are placed in glycerine. Their position is shown in the figures. It will be observed, from Fig. 6, that the vessels unite at the posterior end, at which point there is a terminal pore-like pit.

The foregoing remarks are based on what could be made out without the aid of thin sections. On account of limited time from other duties, and the large amount of material upon which I have to report, I can do little at present in working out the detailed anatomy of the Entozoa referred to me for identification. I have made, however, in this case a few sections which enable me to demonstrate some points in the anatomy of this worm that may be properly recorded in this place.

Anatomy of the head and first segments.—Both transverse and longitudinal sections of the head and first segments and of mature proglottides were made from specimens stained *in toto* in carmine and hæmatoxylon, respectively.

The sections were about .02^{mm} thick.

The first two transverse sections of the head are densely and coarsely granular at center, finer toward the edges, with fine interlacing muscular fibers. The coarse granules are evidently the cut ends of longitudinal muscular fibers. In shape they are irregularly triangular. In the third section the interlacing fibers are more plainly seen and there are besides four clear spaces so situated that if they were joined by straight lines they would mark the four angles of a parallelogram. The coarse granules still constitute the mass of the tissue. In the next three or four sections the clear spaces are better defined and the longitudinal muscles are not so dense at the center. Each clear space is joined to its fellow along the longer side of the parallelogram by a curved line which is convex towards the center. Transverse muscular striæ, .002^{mm}

in diameter and .014^{mm} apart cross each other at right angles in the center, more or less obliquely in the vicinity of the clear spaces. These transverse muscular fibers appear as curved lines with their convexities towards the center of the head. The cross-sections of the longitudinal fibers, while irregular in outline, have a tendency towards triangularity. The greatest diameter of any single fiber measured was .005^{mm}. Other larger patches were observed, but they seem to represent the coalescence of two or more single fibers. The sections of the head are at this point elliptical. The cuticle is not clearly defined. The clear spaces gradually lose their distinctness on account of the increase of transverse fibers. At about the sixth section the transverse fibers begin to be arranged in fasciculi. Two of these fascicles are quite evident and join opposite pairs of clear spaces in the direction of the greater diameter of the section and along the longer sides of the central rectangular space. The longitudinal fibers become less dense along lines which radiate from the angles of the central rectangular space, while between these radiating lines they appear to have become massed together more densely. The clear spaces do not have definite outlines and are certainly not closed vessels. They are crossed by the radiating transverse fibers and appear to have loose cellular or granular contents. This feature is quite evident in the first sections, where nucleated cells were observed in the continuation of these irregularly outlined vessels in longitudinal sections of a specimen stained with hæmatoxylon. Next the two dense masses of longitudinal fibers, which lie opposite and outside of the longer sides of the central rectangular space, appear as two rings of dense granules with a clear center, which is made up of two parts, an inner of transverse or radial fibers, and an outer reticulated part. These two parts soon separate. The inner one, with a deep notch in the middle, is the extreme anterior end of a bothrium, the outer reticulated part is the cuticle of the posterior side of the apical disk of the head. This feature continues for several sections, and shows that the anterior ends of the bothria are above the constriction and near the apex of the head. Transverse fibers predominate in the vicinity of the constriction, while longitudinal fibers predominate in the anterior disk. This fact was confirmed by both transverse and longitudinal sections. The cuticle immediately in front of the constriction is clearly defined and appears in transverse section as a dense layer of fine striæ. It is about .011^{mm} thick.

Clearly defined sections of aquiferous vessels were not found in sections made at the constriction or anterior to it.

The outline of a section at this point is quadrangular, with bluntly rounded angles and concave sides; the two sides on which the bothria lie are very deeply notched. Fascicles or bands of transverse fibers run in a very complicated way from one side to the opposite side and also diagonally from one side to the adjacent side. The longitudinal fibers do not have at this point any definite arrangement. A little farther back the corners of the quadrangular sections project and curve

toward each other where the thin lips of the bothria are cut through. The bottom of the bothria consists of a layer about .03^{mm} thick of dense transverse interlacing striæ. Along the sides the tissue is looser, with open cellular spaces about .005^{mm} in diameter. There is here a more definite arrangement of longitudinal fibers, which now lie in four masses, one in each of the projecting corners of the quadrangular sections. Each of these is at first somewhat circular with a clear central space, a character which is presently lost. A narrow layer also lies along the face of each bothrium immediately under the layer of transverse tissue. Another mass lies opposite the middle of each of the shorter sides of the section. The transverse fibers still predominate, however, and even the masses of longitudinal fibers are quite abundant.

Two large, irregular, clear spaces, crossed by a few transverse fibers and filled with a granular substance, which is but slightly stained by the carmine, indicate the continuation of what was seen in front of the constriction. Besides these there are a number, at least four on a side, of small spaces with definite outlines, which on account of their irregularity in contiguous sections are readily interpreted to be sections of aquiferous vessels which pursue a spiral course. This was further proved from longitudinal sections. Near the middle of the head a transverse section has the appearance of two crescents pressed together by their convex sides. The distance through the head from the bottom of one bothrium to the bottom of the other is only .2^{mm}, while the opposite diameter is .56^{mm}. Several vessels, as many as six on a side, were counted beside the two large irregular, nervous (?) vessels. Each of the latter is .054 by .032^{mm} in its two diameters, the longer diameter corresponding to the longer diameter of the sections. At this point the longitudinal fibers are pretty evenly distributed. Back of the middle the central part of the head grows thicker and wider; the margins, which at first were gently concave and then strongly emarginate, assume a more and more even outline, then bulge out into the rounded convex outlines of the margins of the segments. The head is thus seen to pass imperceptibly into the first segment.

In some of the sections there were remains of what appeared to be a dense layer of columnar epithelium lining the bothria. This layer was still adherent to the inner edge of the thin lips of the bothria and extended nearly to the bottom of the pit. Becoming separated from the underlying cuticular layer the detached portions break up into groups of curved cells. The thickness of this layer, coinciding with the length of the component cells, is .008^{mm}.

The sections which passed through the posterior parts of the bothria also cut the posterior parts of the first segment. As the sections progress through this part, an outer concentric layer, about .09^{mm} thick and containing radiating, transverse, and circular fibers, separates, leaving a central oblong core, which contains the aquiferous and nerv-

ous (?) vessels. The body, indeed, can not be said to be distinctly segmented.

The water vascular system at this point consists of four principal vessels, situated in pairs, each pair lying on the inner side of what I take to be a lateral nervous vessel. The diameter of the aquiferous vessels is from .013 to .027^{mm}. The two nervous vessels are larger, being from .027 to .054^{mm} in their longer, and slightly less in their shorter diameter. Each of the latter is flanked on the sides next the lateral faces by two other small vessels which appear to be of the same nature. No nucleated cells were observed at this point in these vessels, but they contain a net-work of connective tissue, some of the meshes of which are filled with finely granular substance, while others are empty.

An oblong, central part of these sections has the two nervous vessels at its extremities; in it also lie the aquiferous vessels, with an occasional transverse vessel. This central space has a few transverse fibers crossing it, but is made up for the most part of fine connective tissue in which are numerous small cells which are deeply stained with carmine, averaging about .003^{mm} in diameter, and each containing several dark granular specks. These cells are quite different in appearance from the cut ends of longitudinal fibers, and present the same appearance in both transverse and longitudinal section. Moreover, the central core does not show longitudinal fibers in longitudinal sections. Granular cells, similar to the above, are scattered pretty generally through the tissues.

The longitudinal muscles of the body are arranged in four principal bands, two lateral and two marginal. These muscles are very strongly developed. Outside the four bands of longitudinal muscles is a layer of circular muscles with radiating and longitudinal fibers interspersed.

A longitudinal section shows the lateral nervous canals to be somewhat irregular in diameter and without definite walls. They pursue, in the main, an undeviating course, while the aquiferous vessels, which, with reference to the nervous canals, lie towards the center of the body, have a pretty uniform diameter, and pursue an irregularly spiral course. A few nucleated cells were observed in the nervous canals.

Further investigation is needed to demonstrate the exact nature of vessels which I have called nerves.

Anatomy of the proglottides.—Sections made near the posterior end of one of the longest strobiles show an outer, dense granular layer in which are numerous very fine circular fibers with a few radiating fibers. Within this layer, which is about .1^{mm} thick, is another layer of very powerful longitudinal fibers. These occur in fascicles averaging .027^{mm} in diameter. This layer is limited on both sides by a thin layer of circular fibers; it is complete except at the two margins, where there is a short interval where longitudinal fibers are wanting.

The reproductive openings are marginal, about the middle of the seg-

ment, now on one side, now on the other, with a tendency for several to succeed each other on the same side. The cirrus arises from a pear-shaped pouch, whose walls are composed of fine interlacing contractile fibers. In most cases the cirrus is retracted and lies coiled up within the pouch. The larger end of the pouch is directed towards the median line, at its base lies the vas deferens in a voluminous mass. The testes occupy considerable space. The large granular masses, of which they are composed, are most abundant towards the margins, where they fill the central parts of the proglottis. Towards the middle of the proglottis they are displaced by the female genital organs.

The ovaries are situated near the posterior edge of the proglottis near one of the lateral faces, which, for convenience, I will call the ventral face. The ovary itself viewed laterally is an oblong, many lobed organ, made up of globular, nucleated cells, some of which measured from .008 to .013^{mm} in diameter. The ovary in its widest place equals about one-third the breadth of the proglottis, and is about one-half as long as broad. Its average depth in the specimens measured is less than .2^{mm}. From its anterior part the vagina arises and passes outwards towards the margin, then ascends dorsally on a level with the cirrus pouch, the dorsal edge of which it follows closely. It opens near the small end of the cirrus bulb, so that the two organs, cirrus and vagina, have a common cloacal opening on the margin of the proglottis. The position of the vaginal opening was demonstrated only after long and careful search. The oviduct originates at the anterior part of the ovary and is continued into a long and much convoluted tube, which in all the segments, except those that constitute the anterior slender part of the strobile, contains numerous amber-colored eggs.

Before sections were made, ova were seen in little clusters on one of the lateral faces of the body. When sections were made it was discovered that these pores not only actually exist, but that they are of invariable occurrence on the mature segments. They are not in any sense caused by a rupture of the wall of the proglottis, but are definite apertures. They lie on the ventral side, that is, the same side of the proglottis as that on which the ovary lies, and near the anterior edge, a little to one side or the other of the median line. They thus form an irregular zigzag line along the middle of the ventro-lateral face. The oviduct communicates directly with this excretory pore. Mature ova were found in what appeared to be rather immature segments. A shell-gland was demonstrated, somewhat doubtfully, however, in front of the ovary. The egg-inflated oviduct so crowded the middle space of the segment as to render it very difficult to make out the relations of the various parts.

It is to be noted that there is no really clear dividing line between the segments when seen in longitudinal section. The relationship of *Dibothrium* to *Ligula* is thus clearly demonstrated.

5. *Dibothrium plicatum*, Rudolphi.

[Pl. III, Figs. 1–6.]

Echinorhynchus xiphiæ, Gmelin, Syst. Nat., 3047. Zeder, Naturg., 162. Rudolphi, Entoz. Hist., II, 308.
Bothriocephalus plicatus, Rudolphi, Synops. 136 and 470, Pl. III, 2. Bremser, Icon., Pl. XIII, 1 and 2. Creplin, Nov. Obs. 87, Pl. II, 12–14; Ersch. and Grub. Encycl., XXXII, 297. Dujardin, Hist. Nat. des Helm., 614. Van Beneden, Mem. Acad. Belgique, XXXVIII, 36. Olsson, Lund's Univers, Årsskrift IV, 11, Pl. III, Fig. 66. Von Linstow Comp., Helm., 218.
Bothriocephalus truncatus, Leuckart, Zool. Bruchst., I, 37, Pl. I, 13.
Dibothrium plicatum, Rudolphi, Diesing, Syst. Helm., I, 591; Revis., Ceph. Par. 243. Wagener, Nov. Act. Nat. Cur., XXIV, Suppl. 71, Pl. VIII, 94, 95.

This Dibothrium is peculiar to the common sword-fish (*Xiphias gladius*), having never yet been found in any other host. Following is the description given of it by Diesing:

Head sagittate, compressed truncate at the apex, with oblong, lateral bothria. Neck long, somewhat terete, swollen at the base, segments very short, at length longer, with the posterior margin crisp-undulate.

I have referred to this species five specimens of Dibothria from the rectum of *Xiphias gladius*. The head and neck of each of these parasites were completely buried in the walls of the rectum. The part thus buried measured about 13^{mm}. The cavity in which the head and neck were inclosed was, in each case, an enlarged cyst-like space filled with transparent, watery lymph. These spaces were noticed on the outside of the rectum, lying immediately under the serous membrane, and were at first taken to be encysted larval cestods, but upon cutting into one of them the inclosed head and neck, except in one case, to be noticed further on, were observed to be attached firmly to the inner muscular layer of the rectum. After cutting away the remaining tissue from the enclosed necks they were found to be continuous with the bodies of some large Dibothria which lay in the lumen of the rectum and were attached to its walls. The color of the head and neck was bluish-white, that of the body grayish-yellow. After removal from their host the worms were placed in sea-water, where they at once contracted to about one-half their former length, while, at the same time, they became much broader and thicker, with the segments so crowded together that only their posterior edges were visible. They then had assumed the characteristic shape and appearance which is shown in the sketch (Fig. 1). Before they had thus contracted they bore a close resemblance to *D. manubriforme* (U. S. Fish Commission Report for 1886, pp. 456–458, Pl. I, Figs. 1–4). The length of one after thus contracting, exclusive of the head and neck, was 54^{mm}, while its greatest breadth was 12^{mm}. Another measured 66^{mm} in length, with a breadth of 7^{mm} throughout nearly its whole length, narrowing abruptly, however, at the last three or four posterior segments, which measured 2^{mm} in breadth.

The head is short, in preserved specimens oblong, or even orbicular in lateral view, sagittate, compressed in marginal view, blunt at apex. Bothria lateral, each with shallow concavity and thickened edges, posterior border slightly projecting. Length of bothria in two specimens 1.75^{mm} and 2.45^{mm}, breadth 1.58^{mm} and 2^{mm} respectively.

That part of the body may be conveniently called the neck, which, along with the head, is inclosed in the cyst-like cavity within the rectinal walls. It is broader than the head and quite irregular in outline. It is characterized by having the cuticle raised into several irregular, transparent folds. At places the neck is thus rendered much broader than the head. At the point, however, where the rectinal walls are pierced by the neck the latter is compressed on all sides and so reduced to a slender cylinder. At its base the neck enlarges abruptly, becomes transversely striated, and thus merges imperceptibly into the body proper.

Two alcoholic specimens yield the following dimensions for the head and neck:

Dimensions.	No. 1.	No. 2.
	Mm.	*Mm.*
Diameter of head, lateral	1.75	2.00
Diameter of head, marginal	.70	.88
Diameter of neck, lateral	2.85	2.45
Diameter of neck, marginal	1.75	1.40

The measurement for the marginal diameter of the head, given above, was made about the middle of the bothria. Of course the marginal diameter taken through the bases of the bothria would approximate that of the neck. The measurements of the neck were made a short distance back of the head and at about the broadest and thickest part of the neck. At the more slender, cylindrical portions of the neck, near the base, the diameter varies from .5 to 1^{mm}.

The body, at first elongated, when placed in sea-water and in alcohol becomes rather stout. It broadens abruptly back of the neck and soon attains its maximum breadth. In some specimens this is maintained until near the posterior end, in others the body tapers slowly towards the posterior end. The posterior mature segments are very narrow at their anterior end, with broadly flaring posterior borders. Where a few of these are retained on the strobile, they appear like a nest of cups of graduated sizes, with widely flaring lips, piled one within the other. In cases where the narrow posterior segments have been lost the posterior end of the strobile is often deeply emarginate. The segments begin immediately behind the neck, are extremely regular and very short. Their posterior edges are free and project at right angles to the axis of the strobile. They often become undulate with short, crisp folds, which fact imparts the peculiar characteristic appearance to the worm which doubtless suggested the specific name.

In a mature segment which had been placed in glycerine, it was seen that the reproductive aperture, in the shape of a prominent papilla was situated at the margin, or rather on the anterior face of the marginal projection. The diameter of the apex of this papilla, which doubtless represents the base of the cirrus, was $.16^{mm}$.

A single small individual (Figs. 2 and 3), found entirely inclosed and free in a cyst-like cavity, which was filled with transparent, watery lymph, as in the case of the others, appears to be a young specimen of this species. In it the bothria are much more elongated than in the others and the head is truncate with a tumid border projecting on all sides and a minute papilla at the apex. Segments in the shape of fine transverse lines begin immediately behind the head. The posterior segments resemble those of the adult. The specimen is, in fact, a small copy of the larger ones whose bodies were dependent from the inner walls of the rectum. The dimensions obtained from measurements of this small specimen while it was still alive are as follows:

	Millimeters.
Length	13.0
Breadth of head at apex	1.2
Length of bothrium	3.0
Breadth of bothrium	1.2
Diameter of neck	2.0
Length of posterior segments	1.0
Breadth of posterior segments	1.5

The following data with regard to the anatomy of the segments were obtained from a study of a series of longitudinal and transverse sections of portions taken from the middle and the posterior end of an adult specimen. The appearance of these sections, particularly of the longitudinal ones, is very peculiar and indeed unique among the Dibothria. In a series of about ninety longitudinal sections carried through a piece taken from the posterior end of a strobile, only about one-third of the number proved to belong to the segments proper. The remaining two-thirds belonged to the prominent posterior edges which lie about $.06^{mm}$ apart. These edges protrude marginally as well as laterally to a distance equal to nearly one-third the total breadth of the strobile. In longitudinal sections, through the middle of the segments, these free edges form a pectinate border on each margin. Such sections resemble a comb with teeth on the two opposite edges. The teeth are of different shapes, some are acute, others club-shaped. These free edges of the segments consist of two muscular walls with a central space, which is filled with irregular granular bodies. The latter are probably a part of the reproductive system. The reproductive organs proper are borne, not exactly on the margins of the segments, but on one of the lateral faces of the marginal projection. The cirrus pouch is very muscular, and in median section is long, oval, or slipper-shaped. The outer part contains the invaginated cirrus, which seems to be a very thick-walled and muscular organ, at least at the base. The inner

part contains a narrow convoluted tube which appears to be a part of the vas deferens. The coils in the outer part when cut across appeared in section as concentric rings, thus proving that they were the coils of the invaginated cirrus. The coils in the inner part, in the same section, gave no evidence of concentric rings, but were filled with small granules. The latter had sharp outlines and were of nearly uniform size, .003^{mm} in diameter. There was in these sections no evidence whatever of a segmented condition of the body except in the projecting edges. The central part of the body appeared to be absolutely continuous.

The musculature, as revealed by a low magnifying power, consists of an outer circular layer, covered by the cuticle, and an inner longitudinal layer. The latter is very strongly developed. The fibers of which it is composed are many times larger than the circular fibers. They show by their irregular course, looking as if anastomosing with each other in an irregular network, that they were in a state of profound contraction at death.

In some transverse sections from the middle of the body, a convoluted tube was observed which lay beside the cirrus bulb and appeared to open at the outer end of that organ. It follows that face of the bulb which is toward the middle of the marginal projection. Its outer end is wide and appears to be a kind of *receptaculum seminis.* It can be traced to a glandular mass of uncertain outlines, presumably the ovary, in the middle of the segment. If this is the vagina, then both reproductive organs open marginally. It can not be a part of the vas deferens, because the latter was seen as a distinct tube, entering the base of the cirrus bulb and connecting with the coiled tube in the inner part of the bulb.

On a few segments from the middle of the body, small lateral openings were observed, which were situated about half way between the median line and the margin. These were on but one of the lateral faces and were not found on many segments. They are probably pores which communicate with the oviduct and are designed for the escape of ova.

The segments from the posterior end of the strobile have a space in the center filled with ova. These are large with thick shells and granular contents. The normal shape is long oval but owing to the apparently plastic nature of the shells they occur in very various shapes. Measurements of the largest perfect ones gave the length as much as .1^{mm}, with the shorter diameter from .046^{mm} to .063^{mm}. The shell as seen by transmitted light has a thickness of .0025^{mm}. A few ova were observed with one end truncated. From this fact I am led to suspect that the ova of this species may be provided with a terminal operculum for the escape of the embryos, but this can not be demonstrated from my mounted sections.

There are several discrepancies to be found in existing descriptions of this worm. Diesing and others recognize a neck. Dujardin states that there is no neck. I believe that there is no true neck, but that

that part of the body which becomes enveloped by the tissues of its host degenerates into a fleshy cylinder from which all traces of segments are lost. It is easy to see how this result can follow upon such conditions when it is remembered that about the only indication of a segmented condition is the thin projecting posterior edges of the segments, so that when these disappear the central core of the body would appear without segments. For convenience of description, however, it will be well to call that part of the body the neck which in the adult becomes so distinctly modified at the point of attachment.

Olsson states, with a query, that the genital apertures are lateral. Since the apertures in question occur about the middle of the free marginal edges of the segments, and the cirrus pouch lies wholly within that free margin, I think there should be no hesitation in saying that the genital apertures are marginal.

Habitat.—Xiphias gladius. Off Martha's Vineyard, Massachusetts, July 25, 1887. In rectum, five adult specimens, one young.

6. *Dibothrium rugosum* Rudolphi.

[Plate III, Figs. 7-10.]

Bothriocephalus rugosus, Rudolphi. Entoz. Hist., III, 42; Synops., 137. Leuckart, Zool. Bruchst., 57. Dujardin, Hist. Nat. des Helm., 617. Cobbold, Trans. Linn. Soc., XXII, 158, 159. Olsson, Lund's Univ. Arsskrift, IV, 10, Pl. III, Fig. 65. Von Linstow, Compend. Helm. 236.

Dibothrium rugosum, Rudolphi, Diesing, Syst. Helm., I, 591; Revis. Ceph. Par., 240-241. G. R. Wagener, Natuurk. Verh. Haarlem, XIII, 93.

For older synonymy see Diesing's Syst. Helm.

Head sub-sagittate, with oblong lateral bothria. Body with a median furrow and unequally articulate. Length, 300 to 900^{mm}.—*Diesing.*

Length, 300^{mm} to 1^{m}; breadth, 1.2 to 4^{mm}.—*Dujardin.*

Genital apertures marginal, irregularly alternate.—*Olsson.*

I have referred to this species a small lot of Dibothria from the intestine of the cod (*Gadus morrhua*). The specimens were collected by Mr. Thomas Lee, of the U. S. Fish Commission steamer *Albatross*, on the Grand Banks. Mr. Lee stated that he examined one hundred and fifty cod and found parasites in but a few of them.

Each of the specimens in this lot has the head and anterior part of the body buried in the pyloric cæca, where they have undergone degeneration to such an extent that no appearance of bothria remains. Around the parts thus enveloped by the cæca is a yellowish waxy deposit, the degenerated tissue of the cæca. This adventitious tissue invests the worm so closely that it would be absolutely impossible for the parasite to free itself from its host. This feature is mentioned also by Cobbold, who makes the following statement with regard to Dibothria from the cod:

In a cod examined on the 15th of March, 1855, two specimens of *Bothriocephalus rugosus* had severally attained a length of 15 inches, and their anterior segments, for an inch or more downwards, were so firmly impacted within the pancreatic cæca

that it was found impossible to dislodge them without injuring the filamentary head and neck. As if to make the anchorage doubly secure, the cartilaginoid thickening of the invaded pancreatic cæcum had degenerated into a calcareous and contracted cylinder, twisted upon itself in various ways.

The specimens were in alcohol when they were submitted to me; I am therefore unable to give measurements ot living specimens.

The largest of the specimens measures 655^{mm} in length. The anterior part for a distance of 20^{mm} was buried in one of the pyloric cæca and was removed with difficulty, by cutting away the enveloping cæcum. The latter had degenerated into a brown, waxy secretion, which was enveloped by the serous coat, and formed a much twisted, rigid tube surrounding the anterior part of the worm. When this encasing tube was removed, it was found that all appearance of bothria or anterior segments had disappeared. That part of the worm which had been inclosed in the tube was reduced to a slender white filament about .5^{mm} in diameter. In another specimen the inclosed anterior part was irregular in outline and graduated into a yellowish, corneous substance at the tapering apex. In this case the anterior end of the parasite had undergone a degeneration of its tissues similar to that of the cæca of its host.

The body is not distinctly segmented at first, but is crossed by innumerable fine wrinkles. The breadth near the anterior end is 2.5^{mm}. It narrows abruptly at the point of entrance to the cæcum. Near the middle of the body the breadth is 3.5^{mm}, the length of the segments .85^{mm}, increasing to 1^{mm}. The posterior part of the body, for a distance of about 40^{mm}, is much wider, with crowded segments. Breadth, 6^{mm}; length of segments, .45^{mm}. This is evidently due to unequal contraction. Thickness of the body about 1^{mm} in front, and approximating 2^{mm} in median and posterior segments. Another specimen had the following dimensions: Length, 560^{mm}; anterior part, inclosed in cæcal tube, 6^{mm} in length, .4^{mm} in diameter; breadth near anterior end, 2.5^{mm}; middle, 5^{mm}; length of median segments, .7^{mm}; breadth at beginning of posterior fourth, 4^{mm}; length of segments, 1^{mm}; breadth at posterior, 6^{mm}; length of posterior segments, .45^{mm}; body rather plump, posterior half about 2^{mm} thick.

One of the lateral sides of the strobile has a row of apertures making an irregular zigzag series along the median line. These apertures are oblong, the long axis coinciding with the long axis of the body. These lateral apertures were at first naturally taken to be the genital apertures. A careful examination with an ordinary lens revealed what appeared to be marginal apertures. These were indistinct, but I was led to make transverse and longitudinal sections of a series of segments in order to demonstrate the position of the genital apertures.

The first sections were made from segments taken from the posterior end of the body. The marginal position of genital apertures was at once proved. In all cases where they were observed the external openings were obscured by the close approximation of the sides, so as to form

a wrinkle when viewed from the exterior. This fact explained the difficulty experienced in finding the marginal apertures with a superficial examination. The lateral apertures seem to be designed for the escape of ova.

The mature segments, as shown by these sections, are simply sacs with muscular walls for the protection of the eggs. A transverse section is long oval, 2.6 by 1^{mm}. The lateral muscular walls are from .1 to $.16^{mm}$ thick, the marginal walls from .16 to $.24^{mm}$ thick. The segments are separated from each other by a narrow partition from .02 to $.06^{mm}$ thick. A few irregular shreds of muscular tissue and delicate strands of connective tissue extend into the hollow, central part of the segment. Otherwise, the segments are filled with granular bodies about $.03^{mm}$ in diameter. In sections stained with hæmatoxylon these are colored violet; and each is closely invested in a transparent, unstained membrane which has an irregular or tattered outline. Some of these granular bodies which lay near the muscular wall of the segment were inclosed in a net-work of muscular and connective tissue. In these the investing membrane was not so prominent as in those masses which lie farther from the walls of the segment. It would seem, therefore, that the membranous investment of the granular masses is a result of the degeneration or transformation of the muscular and connective tissue of the interior of the segment. In the vicinity of the lateral apertures several collapsed shells of ova were observed. These were unstained, and were .027 and $.016^{mm}$, respectively, in the two diameters.

One undoubted ovum was seen with granular, stained contents, and a very thin, transparent shell, .02 and $.016^{mm}$ in the two diameters. In order, if possible, to prove the real nature of these granular masses I made transverse and longitudinal sections of postero-median segments. In these segments the ovary is voluminous and composed of distinct nucleated cells, nearly circular in outline and from .008 to $.014^{mm}$ in diameter. The nuclei were about $.0025^{mm}$ in diameter. The ovary lies at the middle of the posterior part of the segment with its greatest length transverse to the axis. It equals a little less than one-fourth the breadth of the segment and about one-fourth the length. These proportions must be subject to considerable variation, inasmuch as the ovary disappears completely in the posterior segments. At its thickest point, the ovary extends from the inner limit of one lateral muscular wall to the other. The ova are already abundant in these segments. They are enveloped in a proper shell, which is thin and has an irregular outline, owing to a wrinkling of the surface. This wrinkling or corrugation of the surface is apparently due to a contraction of the protoplasmic contents. They are approximately circular in outline, their average diameter being about $.025^{mm}$. From a comparison of sections made from postero-median segments with those from posterior segments I am led to believe that the granular bodies contained in the latter are ova with incomplete membranous shells.

The testis, in the postero-median segments, is represented by several large granular masses situated towards the marginal portions of the internal cavity. A convoluted tube, lying at the base of the cirrus bulb and communicating with it, is evidently the vas-deferens. This tube appears finely fibrous as if filled with fine filamentary particles. I have noticed a similar appearance in some living cestods in which case the presence of spermatozoa was demonstrated.

I was not able to fix the position of the vagina to my entire satisfaction. In a few sections the cut end of a tube was observed near the cirrus bulb and on its posterior side. This, if it represent the vagina, would indicate that that organ opens behind the cirrus. Olsson, however, figures the vagina of *D. rugosum*, as opening anterior to the cirrus. I may be able to clear up this matter by further examination of the material at my disposal.

Musculature of posterior and postero-median segments.—In passing from the exterior of the muscular wall of a posterior segment to the interior, one finds first a thin cuticle, next a thick, dense granular layer, in which there are very numerous radial fibers which in turn penetrate the third or inner layer. This third layer consists for the most part of very large longitudinal fibers arranged in fascicles. The fascicles, in transverse sections, are somewhat triangular, with the apex of the triangle directed toward the exterior. The triangular transverse section of one of these fascicles measured .05 ^{mm} in length, .03 ^{mm} at base, and .013 ^{mm} at the apex. These fascicles are largest along the lateral sides, and smaller but more numerous at the margins. In longitudinal sections they appear as broad parallel bands of muscular fibers, the individual fibers of which are about .002 ^{mm} in diameter.

The reproductive organs are irregularly alternate and open on the margin of the segment near its anterior edge. In the mature segments only the male organ could be made out. The cirrus was retracted and lay in a slender pouch. This pouch lay wholly in the muscular wall with its base near the interior limit of the wall and its apex at about the limit between the outer granular layer and the inner layer of muscular fasciculi.

The musculature of the postero-median segments was plainly shown in the sections, and some additional data were obtained. The parts are an outer, dense granular layer with fine radiating fibers. On the inner side of this layer is the layer of longitudinal fasciculi. The latter are really immersed in the granular layer. Transverse sections of these bundles are oblong, usually narrowing a little toward the exterior end, occupying a radial position. The largest lateral ones are fully .08^{mm} long and .027^{mm} broad. They are separated from each other by spaces about as wide as their own breadth, and filled with granular and fibrous tissue, in which radiating fibers predominate. On the inner side of the layer of longitudinal fibers is a thin layer of fine circular fibers which

separates, by a sharp division, the muscular wall from the inner cavity of the segment, in which lie the genital organs. This layer of circular fibers spreads out into a thin sheet of fine fibers, at intervals, to form the septum between two adjacent segments. The fibers of this partition are transverse, and run in the direction of the longer diameter of the segment; that is, from margin to margin. This partition is confined to the inner portion of the segment, and does not extend into the muscular walls. Elsewhere in the segment the inner space is crossed by fascicles of fine fibers which pass from one of the lateral muscular walls to the other without interruption, except where displaced by the developing ova.

Following are the measurements of a transverse section of a postero-median segment: From margin to margin, 2.7^{mm}; from side to side, .9^{mm}; thickness of muscular walls, .3^{mm}; marginal diameter of inner cavity, .2^{mm}; lateral diameter of same, .36^{mm}.

Habitat.—Gadus morrhua, pyloric cæca, August 8, 1886, Grand Banks.

Family II.—TETRABOTHRIIDÆ *Diesing.*

Tetraphyllidæ (in part) Van Beneden.

Subfamily I.—PHYLLOBOTHRINÆ Van Beneden.

ANTHOBOTHRIUM Van Beneden.

The generic characters are thus summarized by Diesing: Body elongated, articulate, depressed. Supplemental disks (*auxiliary acetabula*), none. Head separated from the body by a neck. Bothria four, opposite, entire or unilocular, cup-shaped or subglobose, affixed by a contractile pedicel, highly versatile, unarmed. Genital apertures marginal.

7. *Anthobothrium laciniatum*, spec. nov.

[Plate III, Figs. 10–13, and Plate IV, Figs. 1–3.]

Head with four bothria, pediceled, trumpet-shaped, but capable of much diversity of form. Faces of bothria concave, with entire circular margins, but often folded and otherwise distorted by contraction. The head proper, exclusive of the bothria, is very small, often in the living worm appearing to be separated by a slight constriction from the first segment. Neck, in one variety, none, or very short; in another, variable in length, but evident, cylindrical, or quadrate, and terminated behind by four laciniæ. First segments usually much broader than long, rather quadrate, *i. e.*, rectangular in cross-section, laciniate. In some the slender laciniæ of one segment overlap the succeeding segment, and are longer than the body of the segment. In other cases the anterior part of the body is extremely attenuated, in which case the anterior segments may be considerably longer than broad; the laciniæ are then only about one-third the length of the segment proper. In yet

other cases, and usually in those with evident neck, the laciniæ, instead of being long and slender, are short, stout, and truncate at the distal end. Median segments short and crowded, somewhat flattened, and with bluntly rounded laciniæ, or with a broad crenulation on posterior edge. The following segments increase in length, becoming at first as long as broad, subsequently longer than broad. The posterior segments, which may be three times as long as broad, frequently have the anterior end constricted into a short button-like process. The laciniæ persist, but are shorter, broader, and more rounded than at first. Sometimes the posterior edges of the segments are reflexed.

Genital apertures marginal, approximate, about the anterior third or fourth. Length, 25^{mm}.

Habitat.—Carcharias obscurus, spiral valve, Wood's Holl, Massachusetts, August, 1884; July 25, 1887, and August 12, 1887.

This species is near *Anthobothrium cornucopia* Van Beneden, from *Galeus canis*, but differs from it in its smaller size and relatively short neck. The length of *A. cornucopia* is given as 250^{mm}, while the maximum length of *A. laciniatum*, so far as I have observed, is 25^{mm}. Although no specimens were found whose proglottides contained ova, many were found in which the posterior segments were in other respects mature, and separated naturally from the strobile.

Amidst the great variety of forms represented by this species there are two which differ so much from each other that it may become necessary to classify them as constant varieties, in which event they may be named from their principal differential characteristics, var. *brevicolle* and var. *filicolle.*

The former is characterized by having a short or even no proper neck, and usually slender, sharp-pointed laciniæ on the first segments. The latter has an evident neck, and often short, broad, truncate laciniæ on the first segments. For the present, however, I prefer to regard these apparent varieties as simply different conditions of contraction, on account of which the short neck of some becomes more or less elongated in others.

In my explanations of figures I have, for convenience, made use of the terms var. *brevicolle* and var. *filicolle.* These and other characteristic forms are further described in the following detailed account of the species.

I have obtained this parasite on three different occasions, each time from the same host, namely, the dusky shark (*Carcharias obscurus*).

Following are measurements of specimens mounted in Canada balsam. The specimens were collected in August, 1881.

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	21.50	16.00	6.00
Breadth of head	.83	.76	.60
Length of bothrium	.50	.40	.34
Diameter of bothrium, average	.30	.24	.30
Diameter of pedicel at base	.12	.10	.10
Length of neck	1.80	1.10	1.00
Diameter of neck near head	.09	.12	.06
Diameter of neck, base	.14	.12	.20
Length of first segment	.16	.32	.04
Breadth of first segment, front	.12	.10	.16
Breadth of first segment, rear	.16	.12	.16
Length of last segment	1.36	1.08	.68
Breadth of last segment	.56	.56	.18
Number of segments	62	65	60

In No. 1 the anterior segments are squarish, quadrate in cross-section, their posterior corners extended into laciniæ, which, like those at base of neck, are short, stout, and truncate at distal end. In No. 2 the laciniæ at base of neck are like those in No. 1, but on the first segments they are rather slender and not truncate. In No. 3 the first segments are very short and much crowded and the posterior segments have their laciniate borders reflexed like a collar. The last two segments are also somewhat distorted and show a tendency to bend rather sharply towards one margin. This specimen is evidently younger than the others and the variations which it exhibits may be due to differences in age and conditions of contraction.

The laciniæ on the posterior segments of Nos. 1 and 2 are short and broad. The bothria in all are terminally verticillate with conical pedicels that enlarge rapidly towards the face, which is limited by a thick muscular margin.

The following measurements were obtained from living specimens which were collected July 25, 1887:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	19.00	20.00
Breadth of head	.80	....
Diameter of neck, average	.16	.06
Length of neck	.32	1.60
Length of first segment	.18	.44
Breadth of first segment	.18	.16
Length of last segment	1.80	1.00
Breadth of last segment	1.06	.16
Number of segments	120	....

In No. 1, all the segments were remarkably clear cut and definite. The posterior end of the neck and first segment laciniate. At about the twenty-fifth segment back of the head the lappets become rounded and the segments closely crowded together, with a broad emargination on the posterior edge. This emargination gradually deepens as the segments become broader. At about the eightieth segment it becomes a deep round notch which persists in the mature segments. The genital apertures were marginal at about the anterior fourth. The bothria were very flexible and the pedicels extensible. The individuals in this lot exhibit the same varieties noticed in the two other lots. Some of these varieties are described in connection with the lot collected August 12, 1887. It is to be noted, however, that the differences that appear to be so profound in the alcoholic specimens were not so obvious in the living specimens.

The following measurements are of specimens belonging to a lot collected August 12, 1887; No. 1 a living, Nos. 2 and 3 alcoholic specimens:

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	13.50	22.00	14.00
Breadth of head	1.04	1.20	.56
Length of bothrium, with pedicel	.52	.66	.30
Diameter of bothrium	.42		
Diameter of pedicel at base		.04	.12
Distance to first segment	.20		
Diameter of neck	.10		
Length of first segment	.06	.13	.04
Breadth of first segment	.18	.07	.16
Length of last segment	2.00	1.80	1.80
Breadth of last segment	.76	.60	.52
Number of segments	74	70	80

In this lot there were five specimens. They were associated with one specimen of the new species, *Platybothrium cervinum*, eight specimens of *Orygmatobothrium angustum*, nine of *Phoreiobothrium lasium*. All were in the spiral valve. There was also one young purple-red *Rhynchobothrium* adhering to the mucous membrane of the pyloric part of the stomach. The place of attachment of the latter parasite was locally inflamed. There was also another ulcerated spot near by.

In all the *Anthobothria* of this lot the first segments begin almost immediately behind the head, without an evident neck, and this, too, in specimens which are much attenuated in front as well as in those which are much contracted, so that the first segments are short and crowded together.

Two of the alcoholic specimens have the anterior segments very much attenuated. The bothria also are very much altered in shape from what was observed in the living specimens. In them the pedicels are elon-

gated and slender, the bothria surmounting them as flattened or collapsed disks. No perceptible difference could be noticed in these specimens while they were in sea-water. When placed under the compressor, one of them became somewhat attenuated as shown in the sketch (Plate IV, Fig. 1).

No. 2 of the above table was probably the specimen which was kept for some time under the compressor in order to obtain a sketch, and when transferred to the killing fluid, its tissues still retained the position they were forced to assume under the compressor. The bothria in this alcoholic specimen are irregular patellate, mounted on long slender pedicels, and the first segments are very slender, nearly twice as long as broad. The laciniæ are slender pointed and have a tendency to stand out at right angles to the axis of the strobile. In the other alcoholic specimen, No. 3, of the above table, the bothria, although somewhat distorted, have not changed their shape materially from that shown in Fig. 12, of Plate III, sketched from a specimen lying free in sea-water. The bothria are trumpet shaped, pedicels narrow at base but not elongated. The anterior segments are crowded, three or four times as broad as long, with slender sharp pointed lacinæ. The posterior segments in all the specimens are, in the main, alike.

The bothria in two of the specimens in this lot show a peculiar kind of modification, resulting from contraction, which, if but a single specimen were found and so modified, might prove misleading to the identifier. In these, when viewed in certain positions, each bothrium appears to be divided almost completely into two loculi, by a transverse constriction. A careful study of this peculiar distortion reveals the fact that the margin of the bothrium is still entire and the appearance of a constriction is caused by a protrusion of a part of the thin tissue which makes the bottom of the hollow face of a bothrium. The latter is transparent, and the thick, muscular, marginal rim of the bothrium showing through it accounts for the deceptive appearance of two loculi on the face of the bothrium. This same phenomenon was noticed in specimens belonging to the second lot. (See Plate IV, Fig. 2.)

Anatomy of posterior segment.—In one of the posterior segments from a specimen belonging to lot 3, the marginal genital aperture was .6^{mm} from the front end. This segment was 1.8^{mm} in length and was .4^{mm} in breadth at the front end, .62^{mm} at the middle, and .5^{mm} at the posterior end. The ovaries are roundish, somewhat reniform bodies at the posterior end of the segment, lying one on each side of the median line. They are about .36^{mm} in length and .24^{mm} in breadth.

The cirrus, which appears to be smooth, was retracted in all cases. Its bulb is pyriform, at right angles to the axis of the segment, the larger end within. It is .26^{mm} long and .16^{mm} broad at widest part. The vagina was traced in a gently sinuous course along the median line from the posterior end of the segment, at a point between the ovaries, to the cirrus bulb. It bends around the base and anterior side

of the bulb and opens in front of and beside the opening of the cirrus in a common marginal cloaca. The remainder of the interior of the segment was filled with roundish or oval bodies about .025^{mm} in diameter. These are probably the spermatic capsules of the testis.

In looking over an unassorted lot of entozoa from the shark which was examined July 25, I found sixteen additional specimens of this *Anthobothrium.* These present the greatest variety of shapes and furnish examples of most of the forms already noticed, with many intermediate forms. The neck, however, in most of them, was moderately elongated. Two specimens were noted with excessively attenuated necks, the bothria directed forward with their faces appressed.

These additional specimens confirm me in the opinion that the diverse forms comprised in these three lots are specifically identical, the differences being due, mainly, to different degrees and conditions of contraction; while some of the differences are of such regular and constant occurrence as to deserve to rank as varieties, or at least peculiarities of form, which are liable to occur in the preserved specimens.

8. *Anthobothrium pulvinatum* sp. nov.

(*Pulvinus,* a cushion.)

[Plate IV, Figs. 4–9. Plate V, Figs. 1, 2.]

I was at first misled by the appearance of the bothria of this species, which, in the specimens that I had examined when the following description was written, were uniformly convex and corrugated, and that, too, in both the living and the alcoholic specimens.

The specimens were therefore referred to a new genus, *Rhodobothrium,* so named because of the rosette-like appearance of the bothria. It would be unnecessary to mention this change in nomenclature were it not for the fact that I used the name *Rhodobothrium* in a communication to the American Journal of Science and Arts, March, 1889.

I take advantage of an opportunity offered during the progress of publication to note that the bothria of this species may assume a quite different appearance from that which is represented in the figures in this paper. In some cases the muscular ring which surrounds each bothrium contracts to such a degree that the bothrium, together with its pedicel, becomes vase-shaped or even globular. The convex, corrugated surface of the bothrium is, in such cases, retracted, and the bothrium is terminated by a simple orifice or elongated into a papillary termination with the small orifice at its apex. When the bothria are thus contracted the resemblance to Van Beneden's figures of *A. giganteum* (Mem. Vers. Intest., Plate VII, 5–10) is very striking.

The disposition of the genital organs in the mature proglottides is different from that in *E. giganteum*, and the cirrus is echinate instead of smooth.

The specific name *pulvinatum* is retained as descriptive of a common, even if in a measure accidental, condition of the bothria.

Head cruciform, bothria four, directed forwards. The pedicels of the bothria are short, stout, and conical, bearing on their distal extremity the cushion-like bothria which are nearly circular in living specimens, or shaped like the quadrant of a circle in alcoholic specimens. The margins of the bothria are entire at the base, while their upper edges are frilled or ruffled and their faces thrown into corrugated folds. The bothria do not bear any supplemental disks, and there is no terminal papilla or myzorhynchus to the head. Properly speaking, there is no head, the four pedicels simply originate from the anterior end of the body like so many forks. That is, the neck is abruptly quadrivaricate at its anterior end.

The neck is long, flattened, somewhat enlarged, both in breadth and thickness near the head. It is crossed by fine transverse lines which gradually become more distinct and later divide the body into segments.

The body is long and of approximately the same breadth throughout or, in alcoholic specimens, somewhat thickened medianally. The first segments are very short and crowded, increasing uniformly in length; median segments widest, broader than long; first mature segments squarish, then a little longer than broad. Mature segments narrow in anterior diameter, broad behind, at length easily detached. Free proglottides somewhat elongated. All distinct segments with posterior diameter greater than anterior. Genital apertures marginal; male and female approximate near middle of margin. Cirrus very long and echinate.

Length of specimen 550^{mm}, accompanied with great numbers of free proglottides.

Habitat.—Trygon centrura, spiral valve; one specimen, with numerous free segments. Wood's Holl, Massachusetts, August 1, 1887.

The specimen which furnished the data for the foregoing description was very much larger than any of the associated species of Entozoa, of which there were several. The length while living was 550^{mm}, and there were besides, immense numbers of free proglottides, which must have come from this strobile, as it was the only one of the kind found, and most careful and painstaking search was made for small forms. Only a small proportion of the whole number of these free proglottides with which the chyle was swarming was saved. Upon counting the number, however, I find that there are about two hundred of them.

My notes made at the time of collecting contain this description of the head: Seen from the under side, each of the four bothria rises from a short, smooth, conical pedicel, which enlarges rapidly toward the distal end. The outer half of the length is made by the frilled and puffed margin of the cushion-like bothrium, which at first projects abruptly about midway from the base of the pedicel to the outer surface of the

bothrium and beyond the middle point is thrown into numerous small folds (Plate IV, Fig. 5). In front view, the bothria look like a cluster of white rosettes with contiguous edges in contact, and thus leaving a four-sided central space. There is no indication of a terminal papilla to the head or supplemental disc on the bothria. In the alcoholic specimen the outline of the bothria has changed from nearly circular to that of a sector of a circle. This is caused by the flattening of the sides of the bothria, which touch each other.

Although the specimen was rather active when first placed in sea-water, it showed little tendency to change either the shape or the relative position of the bothria. After it had lain in sea-water for twenty-four hours it still exhibited moderate activity. The bothria were then found to be 3^{mm} in length, measured from the base of the pedicel to the outer margin of the convoluted face, when the head was inclined forward so as to lie nearly on the faces of the bothria.

The resemblance of the head of this worm to a head of cauliflower is very striking. This simile has been employed by Van Benden also in his description of *Phyllobothrium lactuca.*

The living specimen had the following dimensions: Length, 550^{mm}; diameter of head across the top, 4.5^{mm}; diameter of neck near the head, 1.6^{mm}; thickness of neck, 1.1^{mm}; length of last segment, 2^{mm}; breadth of last segment at anterior end, 1^{mm}; at posterior end, 2^{mm}. The spiral intestine contained enormous numbers of free proglottides which were about 4.5^{mm} long and 3^{mm} broad.

In the alcoholic specimen the breadth of head across the top is about 4^{mm}; diameter of a single bothrium 2.4^{mm}; diameter of pedicel at base, 1.1^{mm}, near bothrium 1.4^{mm}; length of pedicel and bothrium 1.6^{mm}.

Immediately behind the head the neck is a little wider and much thicker than it is one or two millimeters farther back. Fine transverse lines are visible almost immediately back of the head, but distinct segments do not appear until about 25^{mm} back of the head. The transition from fine transverse lines to the sharp division into segments is so gradual, that the first distinct segments can be located only for a limit of four or five millimeters. At the distance of 60^{mm} from the head the segments average 2^{mm} in breadth and about $.03^{mm}$ in length. At this point the segments are broader on the posterior edge than the anterior. The posterior corners are therefore slightly salient and sharply and clearly cut. For the last 200^{mm} the segments appear to be mature. They did not, however, separate easily. They have a rounded or parabolic outline in front and are quite distinct from each other. The transverse line, which marks the division between two segments, is much shorter than the base of the segments. The mature segments are uniform in size, and symmetrical. The cirrus was extended in many of the posterior segments as much as $.9^{mm}$, with a diameter at base of from $.1$ to $.16^{mm}$ and at apex of $.08^{mm}$. In the alcoholic specimen some of the cirri are extended farther than they were observed to be in life.

Many were from 1 to 2^{mm} in length, and one very slender one 3^{mm}. The cirri are provided with short, sharp-pointed, broad-based, recurved spines. Their length is about $.005^{mm}$. They are inserted on an epidermal investment of the cirrus, which is easily detached.

Some of the vessels of the water vascular system can be seen when the specimen is made transparent in glycerine or oil of cloves. Two large spiral vessels were seen in the neck near the head. A short distance back of the head they appear to lose their spiral character. In the head they divide and send branches through the pedicels to the bothria.

Anatomy of mature segments.—Fascicles of longitudinal muscle fibers were observed in sections of mature segments. These, which were stained deeply with carmine, differ from the longitudinal muscles which I have thus far observed in the Cestods in being distinctly and abundantly nucleated. The fascicles, indeed, appear to be made up principally of small fusiform muscle cells, which are about $.0014^{mm}$ broad and $.0055^{mm}$ long. The fascicles themselves vary in breadth from .005 to $.014^{mm}$, with varying intervals between approximating the breadth of the fascicles. The intervals between the fascicles are filled with granular tissue. Outside the fascicular layer and outside of this again is a layer which contains fine transverse, circular, and longitudinal fibers. The circular fibers lie outside the longitudinal fibers.

In the free segments the ovaries are seen as large lobed organs lying symmetrically on each side of the median line. The middle of the segments is crowded with ova. Near the margins, on each side, are the granular masses of the testes, while near the anterior end is a large convoluted tubular mass, made up, for the most part, of the voluminous vas deferens. The cirrus is of extraordinary length and quite slender. When retracted, the sheath extends into the interior of the segment, its base lying close to the posterior folds of the vas deferens. The latter in section is seen to be packed with exceedingly fine fibrous material, which appearance I take to be due to the presence of spermatozoa.

The course of the vagina was not satisfactorily traced throughout its entire extent. Its external opening is immediately in front of the cirrus, there being, in fact, but a single external opening for the genital organs. It lies close beside the front edge of the cirrus sheath. At the base of the latter it changes its course from one at right angles to the axis of the segment and is inclined gently towards the front end of the segment. I have not yet succeeded in tracing it in a continuous line to the ovary, but in several sections the vaginal tube was seen both near its outlet and in the midst of the lobes of the ovary. It seemed to disappear in the vicinity of the vas deferens. As only mature segments were cut into sections, it seems probable that the tissues of the vagina had already been absorbed to a considerable extent in its middle course, in order to give room for the ova, which are not confined to a definite uterus, but appear to fill the whole inner cavity of the segment.

The vagina near its beginning is tubular, but near the base of the cirrus sheath it is thrown into short, crisp folds, so that the walls in section appear frilled or ruffled.

The ovaries in section when highly magnified are seen to be made up of what appear to have been originally spherical bodies, but which on account of mutual pressure have become somewhat polyhedral. They measure from .008 to .01^{mm} in diameter. The free segments contain a few ova. These are oval in shape and had a smooth thin transparent shell, measuring .028 and .036^{mm} respectively in the two diameters. The shell incloses a granular mass which measures .014 and .019^{mm} in its two diameters.

Associated with the ova were some spherical granular masses .028^{mm} in diameter.

Upon examining a lot of small specimens from the same host that yielded the large specimen I find an exceedingly small individual which I shall, for the present, refer to this species. Its dimensions, from the alcoholic specimen, are the following: Length, 4^{mm}; diameter of head across top, .52^{mm}; diameter of single bothrium, .32^{mm}; length of bothrium with pedicel, .18^{mm}; diameter of pedicel, .12^{mm}; diameter of neck, .10^{mm}, swelling immediately to .16^{mm}; distance from head to first segments, .4^{mm}; length of first segments, .04^{mm}; breadth, .14^{mm}; length of last segment, .32^{mm}; breadth, .18^{mm}.

There are about twenty-three segments in all. It agrees with the larger specimen in the general appearance of the head, the disposition and outlines of the bothria and pedicels, although the faces of the bothria are not so distinctly convoluted. It differs in having a slight constriction back of head, and in the character of the segments, which instead of being short and crowded at first, soon become square, and before the middle of the strobile is reached, are a little longer than broad.

Since writing the foregoing description I have received from Dr. E. A. Andrews, of Johns Hopkins University, a single specimen, which I refer to this species. It was found in the spiral valve of a sting ray at Beaufort, North Carolina, August 8, 1885. The specimen has no mature segments. One bothrium is missing; the stump of its pedicel remains, however, to show the position of the bothrium. It differs from my specimen principally in its smaller size, in the relatively finer convolutions on the faces of the bothria, and the cylindrical, instead of conical, pedicels.

The length is 35^{mm}; diameter of head across the top, 2.48^{mm}; diameter of single bothrium, 1.25^{mm}; length of bothrium with pedicel, .9^{mm}; diameter of pedicel, .48^{mm}; diameter of neck, .68^{mm}. The segments are all very short and crowded, their length at posterior end of strobile being about .12^{mm}, and their breadth 1^{mm}.

The head of this specimen was stained with carmine and cut into transverse sections. The first sections show that the fine convolutions

which cover the bothria are composed of dense granular tissue. The convolutions in this specimen are rather narrow, measuring .014^{mm} in diameter. The sections very soon reveal the presence of what appear to be strong longitudinal fibers, their cut ends measuring as much as .006^{mm} in diameter. A little deeper and sections of large aquiferous vessels appear in each lobe, and the large muscular fibers become indistinctly fascicled. The irregularly sinuous aquiferous vessels traverse the bothria and unite in each pedicel into large vessels which lie so close together as to resemble a double tube. These evidently represent the afferent and the efferent vessel of each bothrium. A branch of this system near the face of a bothrium, in close vicinity to the convolutions, measured .027 and .022^{mm} in its two diameters; in the pedicel they were .032^{mm} in diameter.

Near the base of each pedicel and lying near the aquiferous vessels there is what appears to be a nervous mass from which branches ramify to the convolutions of the bothria. These branches, as well as the mass from which they originate, are sharply differentiated from the surrounding tissue, are neither tubular nor striated, but uniformly and finely granular. (Plate v, Fig. 1.)

The first sections to pass through the head are cruciform in outline. It is here seen that many of the large muscles seen in the first sections and supposed to be longitudinal are really transverse. Two fascicles of these muscles from each pedicel cross the head, are continuous with those of the opposite pedicel and at right angles to those belonging to the adjacent pedicels, thus forming a square in the center of the section. The inside of this square is filled with fine granular tissues. Following these sections are others which show fascicles of muscles passing from the base of one pedicel into the adjacent pedicels through whose tissues they ramify. These fascicles make a decussation in each axilla. Outside of each decussation there is a bundle of coarse longitudinal fibers in each axilla.

Two of the sections through the center of the head have a large central space filled with fine granular tissues from which branches proceed into each pedicel. I take this to represent the cephalic nervous system. A section which passes through the base of the head has a large rectangular central space .32^{mm} long and .24^{mm} broad, surrounded and limited by a layer of fine circular fibers and containing the large aquiferous vessels which here lie in loose coils. The remainder of the body wall outside the layer of circular fibers is composed of a layer of longitudinal fascicles of muscles which extends to the cuticular layer. This section passes a short distance into the pedicels which are here composed of large muscular fibers from the outer layer of longitudinal muscles. A few sections farther back the central space which contains the coils of aquiferous vessels is more nearly square, Plate IV, Fig. 8. The surrounding layer of circular tissue sends out numerous branches which ramify through the surrounding layer of longitudinal fibers forming a

loose spongy layer of tranverse tissues in the interstices of which the longitudinal fibers lie. The anastomosing branches of this spongy or irregularly reticulated layer unite again at the surface in a rather thick cuticular layer of circular fibers. A few sections further on the following dimensions occur: central space .3^{mm} long and .16^{mm} wide; thickness of circular layer .009^{mm}; thickness of reticulated layer .06^{mm}; thickness of cuticular layer .014^{mm}. The aquiferous vessels are here not so much folded. The central space contained the cross section of one pair and the longitudinal section of a coil of the other pair. The remainder of the central space contained some loose areolar tissue. The inner space grows narrower very rapidly as sections proceed from the head, and is speedily reduced to a narrow oblong space or core, enlarging slightly towards the margin, and containing a pair of aquiferous vessels near each extremity. Each pair of vessels consists of a larger and a smaller vessel, lying side by side, the larger one towards the center of the segment. Between the outer aquiferous vessel and the margin there is a smaller vessel without distinct outline. These two marginal granular vessels or cords can be traced from the cephalic granular mass. At the base of the head they lie on opposite sides of the rectangular central space and outside the layer of circular fibers. The diameter of one of the larger vessels was .045^{mm}; diameter of smaller vessel .032^{mm}; diameter of nervous vessel .022^{mm}; length of inner core .45^{mm}; breadth of section of inner core at middle .022^{mm}; thickness of section .4^{mm}; breadth of section .6^{mm}. The narrow core within its limiting layer of circular fibers is composed of granular tissue, and is at this point reduced to a very slender line. As the sections proceed the layer of circular fibers which surrounds the central core becomes thinner and in the last sections made, about 1^{mm} back of the head, had become almost entirely dissipated, so that the layer of reticulated or anastomosing tissue extended from the cuticular layer to the granular core.*

ECHENEIBOTHRIUM Van Beneden.

The characters of this genus, according to Diesing, are:

Body elongated articulate. Head continuous with the body or separated by a neck with a terminal retractile myzorhynchus. Bothria four, opposite, transversely costato-plicate, sometimes provided with longitudinal partitions, attached by the posterior margin to the head by means of a contractile pedicel, versatile, unarmed. *Os* in apex of myzorhynchus. Genital apertures marginal.

I have separated those species which have the characteristic echeneiform bothria, but are destitute of a myzorhynchus, from the genus *Echeneibothrium* and have placed them in a new genus *Rhinebothrium*.

* Dr. J. Niemiec, "Untersuchungen über das Nervensystem der Cestoden," in Arbeiten aus dem Zoolog. Institute zu Wien, T. VII, pp. 1–60, Taf. 1 u. 2, 1888, describes the nervous system of *Anthobothrium musteli*. It bears a close resemblance to that which I have made out in *A. pulvinatum*.

9. *Echeneibothrium variabile* Van Beneden.

[See Report of U. S. Commissioner of Fish and Fisheries for 1886, pp. 460–462, Plate I, Figs. 9–13, for description and synonymy.]

I have already noted the occurrence of this parasite in the common skate (*Raia erinacea*). Since the description which is referred to above was published, I have found this *Echeneibothrium* on two different occasions. On August 29, 1887, I examined twenty-four skates. Their stomachs were filled with small crustacea, for the most part *Crangon vulgaris*. Some of them contained, beside these, a few Annelids, such as *Nereis* and *Rhynchobolus*. Many of the skates had no parasites. About a half a dozen specimens of *E. variabile* and one specimen of *Rhynchobothrium erinaceus* were obtained from the spiral valve and a few *Nematods* from the stomach and spiral valve of a few. On September 6, 1887, I examined ten skates and obtained from the lot four specimens of *E. variabile.*

I add the following data, based for the most part on notes made while observing the living worms.

The following measurements are from one of the living specimens of the first lot: Length 55^{mm}; length of bothrium, including pedicel, varying with contraction from .5 to 1^{mm}; diameters of face of bothrium .24^{mm} and .6^{mm}; diameter of myzorhynchus at base about .26^{mm}, length .08^{mm}; diameter of neck .14^{mm}; distance to first segment 1.4^{mm}; length of first segment .025^{mm}, breadth .16^{mm}; length of median segments .3^{mm}, breadth .22^{mm}; length of last segment 1.26^{mm}, breadth .42^{mm}.

The segments were transversely rugose. The head was opaque, ivory white; central core of neck also dense, opaque, white for .4^{mm} back of head. When placed in Perenyi's fluid this specimen shrunk to 30^{mm}. Another specimen in the second lot was first placed in fresh water, then transferred to alcohol; it measures as an alcoholic specimen 44^{mm}. It was not measured while living, but it did not shrink so much as the specimen which was killed in Perenyi's fluid.

It is very difficult to ascertain the exact number of the loculi on the face of a single bothrium. The plan of arrangement, however, seems to be as follows: Three transverse costæ and a middle partition divide the face of each bothrium into about eight loculi. Of these, three pairs are median and two single loculi are terminal. The bothria, although undoubtedly capable of expanding broadly, have a tendency to contract and close up by the appression of the sides and ends, and this too when first placed in sea-water. Some of the specimens are so much contracted as almost entirely to conceal the bothrial cortæ. None of the specimens in these lots showed the posterior elongation of the head noted and figured in my former paper. One specimen, measuring 27^{mm} in length, was not so active as the others; moreover no loculi could be discerned, although the general appearance of the head was the same as that of the others. The last segments, which were about .6^{mm} long and .4^{mm}

broad, were convex on the margins and bluntly rounded at the ends. Another specimen, 10^{mm} in length, had a very irregular outline, the neck greatly enlarged and the segments much shortened by contraction. A fragment, 13^{mm} in length, although without a head, exhibited a decidedly progressive motion. The segments were in a state of activity; their proportions of length and breadth changing rapidly. Some of the segments of this fragment, when stretched out, had the shape of an elongated parallelogram. One, while in this position, measured .4^{mm} in length and .16^{mm} in breadth; when contracted it was nearly square, with convex margins, and measured .3^{mm} in length and .26^{mm} in breadth.

A small specimen, 6^{mm} in length, presents some anomalies. The bothria are small as compared with the myzorhynchus. The latter is elongated, conical, smaller at apex than base.

When one of the normal scolices was compressed the bothria contracted, and, so to speak, were absorbed in the head. The head was rather swollen and globular, while the faces of the bothria, on the side of the globular head, resembled the sucking disks of *Tœnia.*

When pressure was relieved the bothria were protracted again on elongated pedicels, and became very variable in shape and size. When the bothria were thus extended the head proper was much reduced in size, and the pedicel of the bothria gave it a cruciform shape.

The myzorhynchus was not observed to change its shape much, but it is evidently capable of changing its form. There is a terminal *os* which leads to an inclosed globular proboscis. It is probable that this organ is susceptible of great variation in form, but I have never observed it exhibit any other change than that which was incident to greater or less protrusion.

One peculiarity, which appears to be characteristic of this worm, is the cylindrical form of the anterior part of the body. The neck, or jointless part of the body, is cylindrical, as are also the anterior and median segments. The mature segments are also quite plump, but often irregular in outline. In all the specimens which furnished material for these data, the segments, with the exception of a few mature ones, are exceedingly regular. The margins are parallel, and the posterior edges project little, if any, so that the strobile for its anterior and median portions has an almost entire outline. The cirrus, although not protruded in any case that was brought under observation, was plainly seen as it lay coiled up in its bulb. It is slender and echinate throughout its entire length.

Olsson figures *E. variabile*, with a rosette-like myzorhynchus, a feature that I have never observed in any of my specimens. These specimens which I have referred to *E. variabile* are also much like *E. affine* of Olsson. I have not yet had an opportunity to examine type specimens of European species. Upon comparison with type species this form may prove to be specifically different from any of the closely related European species.

RHINEBOTHRIUM gen. nov.

[῾Ρίνη, a rasp.]

Body articulate. Head continuous with the body or separated by a neck. Neck merging into segmented body or separated by a constriction. Bothria four opposite or in lateral or marginal pairs, faces divided into loculi by several or many transverse and one or few longitudinal muscular partitions, mounted on slender pedicels, very versatile, unarmed, myzorhynchus none.

Genital apertures marginal.

The genus *Rhinebothrium* is established to accommodate species with echeneiform bothria, but which have no terminal proboscis of any kind. The presence or absence of such a complicated organ as the myzorhynchus of *Echeneibothrium* appears to one to indicate a generic difference. If this view is correct, then species like Van Beneden's *Echeneibothrium minimum* should be referred to the genus *Rhinebothrium.*

10. *Rhinebothruim flexile* sp. nov.

[Plate V. Figs. 3-5.]

Bothria four, opposite, long, slender, versatile, attached at middle point to head by moderately short pedicels. Face of each bothrium with numerous loculi in two longitudinal rows, forty, more or less, in each row. The slender, free ends of the bothria very versatile, bending readily in any direction, but especially in the plane of the supporting pedicel and axis of the body. An apparent hinge in middle of face of each bothrium opposite the pedicel. No head, strictly speaking, except what is formed by the bothria and their pedicels. Myzorhynchus none. Neck short, cylindrical, merging imperceptible into the body. Segments begin near the head. First distinct segment broader than long, very soon becoming squarish, then longer than broad; mature segments six or eight times as long as broad, subcylindical or fusiform, narrowed at the extremities.

Genital apertures marginal, about middle of segment; cirrus echinate.

Maximum length 16^{mm}; length of posterior segments from 1 to 1.6^{mm}, breadth .2 to .32^{mm}.

Habitat.—Trygon centrura, spiral valve, twenty-five specimens, Wood's Holl, Massachusetts, August 10, 1887.

This species possesses some characteristic features which ally it with Van Beneden's *E. minimum* from *Trygon pastinaca.* This is especially true in respect to the shape of the mature segments and the entire strobile, in fact, excepting the bothria. The differences shown by the latter, however, are too profound to allow them to be referred to the same genus. This difference can be readily appreciated when it is remembered that *E. minimum* is characterized by having the bothria crossed by eight to ten transverse septæ, while *R. flexile* has in the neighborhood of forty.

I found some difficulty in ascertaining the exact number of costæ and resulting loculi, on account of a tendency on the part of the bothria to curl up at the free ends. The arrangement of the costæ is as follows: A thick double muscular band traverses the middle of the face of each bothrium from tip to tip, like the keel plank in the frame-work of a skiff. From this middle partition numerous ribs rise, curving outward and upward to unite in a thick crenulated rim, which forms the border of the bothrium. To carry out the figure of the skeleton of a skiff, the curving costæ answer to the ribs, and the thick crenulated rim to the gunwale. The costæ are arranged with perfect symmetry on the two sides. I am not yet certain as to the exact number of these costæ, nor am I certain that the number is precisely the same in every individual. I have counted as many as were in view and estimated the number in concealed and obscure parts with varying results, viz, from thirty-two to forty and upwards on a side, thus making, in round numbers, from sixty to eighty loculi on the face of each bothrium. The bothria have a tendency to bend abruptly at the middle on a transverse hinge-like line. The margins of the bothria are usually slightly notched at the extremities of the hinge. The head of the living worm is almost transparent and the bothria are exceedingly active. On account of their transparency and gracefully curving outlines they are very beautiful objects. The pedicels were not observed to contract or lengthen appreciably, and in the preserved specimens they have changed their proportions but slightly from what they were in life. In the alcoholic specimens the pedicels have about the same diameter as the neck, or a little greater, and their length does not quite equal their diameter. They appear to be arranged cruciformly. The bothria in the alcoholic specimens are variously bent. In some their free ends are turned towards the axis of the body and so curled up as to give the head an almost globular outline. In others the bothria are turned in the opposite direction. The pedicels, as to their origin, are like so many forks branching abruptly from the apex of the neck, and the bothria are like a terminal whorl of four petiolulate leaflets at the summit of the petiole of a compound leaf. There is, therefore, scarcely anything that can be called a head, if the bothria and their pedicels are disregarded. The short, cylindrical neck is, in some cases, slightly enlarged a short distance back of the head.

In five specimens of the lot of about twenty-five there was a small red spot in the center of the neck near the base of the pedicels. There do not seem to be any correlated features to distinguish these specimens with the red spot in the neck from the others in which no red spot is visible.

The two sorts were placed in different vials at the time of collecting, but the red coloring matter is dissolved out by the alcohol, so that when I came to study this species after they had been preserved for some months, there is nothing but the label on the vials to tell that there was ever any difference between the two lots.

The neck is crossed with fine transverse lines which, in less than a millimeter back of the head, outline the first segments. These for a short distance are very short but increase in length rapidly. In an alcoholic specimen, at the distance of 1.4^{mm} from the head, the segments are as long as broad; at a distance of 3^{mm} they are a little over twice as long as broad; about the middle of the strobile their length is five times their breadth; the last segment is seven times as long as its greatest breadth; the entire specimen measured 14^{mm} and the last segment 1.4^{mm} in length.

The breadth of the body remains nearly uniform throughout. The posterior segments are usually rather narrow at the two extremities and swollen in the middle in the vicinity of the reproductive aperture. The dimensions of one mature segment, somewhat flattened, are: diameter near anterior end .16^{mm}; diameter in front, at junction with preceding segment, .1^{mm}; diameter at middle .22^{mm}; diameter near posterior end .12^{mm}; diameter at junction with succeeding segment .08^{mm}.

When mature segments are placed in glycerine and studied with a low magnifying power, the ovaries may be seen as two long, somewhat opaque bodies, lying at the posterior end of the segment, one on each side of a transparent median space and extending nearly to the middle of the segment.

The reproductive aperture is marginal, about the middle of the segment. The cirrus was retracted in all the specimens, but it could be seen, together with the *vas deferens*, lying in a coil in the middle of the segment. Several large ova were observed lying loosely along the median line, from the anterior end of the segment back to the front end of the ovaries. These ova vary greatly in size and shape. They appear to be quite large in proportion to the size of the segment, and are, moreover, comparatively few. Measurements of average ova yielded the following results: .017 by .011^{mm}; .019 by .01^{mm}; .022 by .011^{mm}; .017 by .013^{mm}. An elongated ovum measured .05 by .011^{mm}; another .047 by .014^{mm}; a pear-shaped one was .03^{mm} long, .014^{mm} in its greatest breadth, and .008^{mm} in its least breadth.

The following measurements were obtained from living specimens:

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Length	7.50	13.50	16.00	15.00
Breadth of head	.80	.60	.80	....
Length of bothrium	.60	.80	....	.80
Breadth of bothrium	.10	.20	....	....
Breadth of neck	.09	.10	.24	.10
Distance to first segment	.40	.50	.60	.60
Length of first distinct segment	.05	.03	.04	.04
Breadth of first distinct segment	.10	.16	.26	.10
Length of last segment	.20	1.04	1.40	1.60
Breadth of last segment	.20	.24	.34	.24
Number of distinct segments	21	34	40	35

Nos. 1 and 2 had the red pigment spot in the neck; Nos. 3 and 4 were without any red coloring matter in the neck; Nos. 1 and 3 were somewhat flattened under the compressor; Nos. 2 and 4 were not compressed; in No. 2 the neck immediately behind the bothria was slightly swollen and measured .2^{mm} in diameter, while beyond the swollen point its diameter was as given above; in the same specimen the fifth segment from the end was .88^{mm} in length; in No. 4 there were twelve mature segments. All the mature segments were thickest in the middle and tapered towards both ends.

The vessels of the water-vascular system are very distinct in the living specimens; they could be traced from the anterior part of the body, where they lie near the margins, through each pedicel to the bothria. Each pedicel contains two vessels, one of which communicates with one of the marginal vessels of the neck and the other is continuous with one of the vessels in the diagonally opposite pedicel; these vessels are all sinuous. Strong bands of longitudinal muscles run from the neck into the pedicels and to the bothria. As each of the numerous loculi acts as an independent cupping-disk, their combined action must enable the parasite to adhere with considerable power to the mucous membrane of its host. The cirrus, although retracted in every case, was seen in sections of a segment to be covered with spines; the cirrus appears to be slender and the spines are minute.

In size of strobile, shape of segments, size of ova and echinate cirrus, *R. flexile* agrees with Van Beneden's *E. minimum*. There was not a single individual in the lot of twenty-five specimens, however, whose bothria agree with *E. minimum*.

11. *Rhinebothrium cancellatum* sp. nov.

[*Cancellatus*, latticed.]

[Plate v, Figs. 6–8.]

Head with four lateral bothria, which are elliptical and mounted on short pedicels; faces of bothria with about twenty-one loculi arranged somewhat trilineally; anterior margins of bothria free, slightly projecting, posterior margins appressed, neck broad and flat at base of bothria, somewhat constricted behind head, and almost immediately crossed by fine, closely-crowded, transverse lines; distinct segments make their appearance 1^{mm} or less back of head; the segments are much broader than long throughout the length of the strobile until near the posterior end, where they are as long or even longer than broad; they are convex on the margins, so that the marginal outline of the strobile is crenulate; the chain of posterior segments is rather moniliform; the anterior and median parts of the body are crossed at more or less regular intervals by distinct transverse lines, which give rise to the deceptive appearance of elongated transversely wrinkled bothria; body rather flat and thin;

length, 25^{mm}; breadth, 1 to 1.5^{mm}; genital apertures marginal; cirrus echinate.

Habitat.—Rhinoptera quadriloba; spiral valve; three specimens; Wood's Holl, Massachusetts, July 20, 1887.

The three specimens which furnish the data for the present description were found in the posterior fold of the spiral valve of the cow-nosed ray (*Rhinoptera quadriloba*).

When first placed in sea-water they were rather active. The extended bothria gave the head somewhat the appearance of a peltate leaf. The face of each bothrium is divided into twenty-one pits or loculi. The arrangement of these loculi in every case in the living specimens appeared to be definite and the number constant. There is first a longitudinal row of five comparatively large loculi, occupying the middle line of the bothrium; then a small pit at each end, and seven pits on each side, making twenty-one in all. The loculi are larger towards the posterior end of the bothria than they are in front. In alcoholic specimens the edges of the bothria are curled inwards so that it is not always easy to count the exact number of loculi. The characteristic appearance of a circle of about sixteen loculi around the circumference of the bothrium and a longitudinal row of five at the bottom of the face of the bothrium can be made out in most cases. In one of the specimens, when cleared up in oil of cloves, there appeared to be eighteen loculi around the border, which, together with the five central ones, would make twenty-three instead of twenty-one. From this circumstance I am therefore as yet in some doubt as to whether the number of loculi is always constant. The ribs which outline the loculi are thick and muscular and give to the margins of the bothria a crenulate outline. The pedicels are very short and thick. The bothria are lateral, their posterior ends rather thick and slightly flaring. In consequence of this the head of alcoholic specimens is sagittate in marginal, squarish in lateral view. In the living worm, when at rest, the bothria are elliptical.

The first segments begin as fine transverse wrinkles. In one specimen the first distinct segments began about 1^{mm} back of the head and were .03^{mm} long and .4^{mm} broad. What appears to be a characteristic of the species is the occurrence at short intervals of very distinct transverse lines which divide the body into pseudo segments. These upon superficial examination might be mistaken for true segments. When examined carefully, however, they are seen to be made up in each case of a number of true segments. In one specimen the first of these transverse lines appeared 3.2^{mm} back of the head, the next 3.8^{mm}, and following this two others 5 and 7^{mm}, respectively, from the head. These pseudosegments are formed in some cases by the natural division between two segments becoming very distinct, in others by an entire segment becoming thin and transparent.

Following are the measurements, in millimeters, of a living specimen:

Length, 25.55; length of bothrium at rest, .7; breadth, .53; breadth of head, 1.23; breadth of first segments, about 1 back of head, 4; length, 03; breadth of median segments, .72; length, .15; average length of posterior segments, .13; breadth, .8.

In the above specimen there was a constriction behind the head .28^{mm} in diameter, while immediately behind the constriction the neck was .46^{mm} in diameter. Near the posterior end of the strobile there was an enlargement due to contraction, which was 1.1^{mm} in diameter. In another specimen, 20^{mm} in length, the first segment began less than 1^{mm} from the head, where they were .8^{mm} broad and .05^{mm} long. The median segments were 1.4^{mm} broad and .1^{mm} long. The posterior segments were narrower, breadth, .44^{mm}, length, .46^{mm}, with rounded angles, the strobile here being somewhat moniliform.

The vessels of the water-vascular system were quite evident in the living specimens, both in the body and the bothria. One set of longitudinal vessels, consisting of a single vessel near each margin, was peculiar in that each vessel was quite irregular, swelling out into suboval enlargements and giving off short lateral branches at intervals. These may be nervous vessels.

When the specimens were placed in alcohol the longest of the three contracted until it was shorter than the others.

Anatomy of the segments and bothria.—A few of the posterior segments of one specimen were stained with carmine and cut into longitudinal sections. The segments all proved to be immature, and consequently only a comparatively few points in their anatomy could be made out.

The outer coat of the muscular wall is composed of two layers of finely fibrous tissue, an outer layer of circular, and an inner of longitudinal fibers. In sections these two sorts cross each other at right angles, forming a net-work with rectangular meshes. Beneath the outer fibrous layers is a thick layer of densely granular tissue. The granules stain deeply with carmine, and are from .003 to .006^{mm} in diameter. Beneath the granular layer is a layer of longitudinal muscle fibers. These are larger than the fibers in the outer longitudinal layer, and are arranged in straight, parallel fascicles, which are from .0025 to .005^{mm} broad and .0025^{mm} apart.

The most prominent organ in these segments is the cirrus and its sheath. In all cases the former was retracted. The external opening of the cirrus is at the margin near the anterior edge of the segment. The sheath, with the inverted cirrus, extends a little past the middle line of the segment. The cirrus when extruded must be therefore relatively quite long. The sheath enlarges towards the center of the segment, where its diameter nearly equals the length of the segment. The length of one was .28^{mm}; its diameter at base .027^{mm}. The cirrus throughout all its length is thickly beset with spines. The spines at the base are much longer and stouter than those along the middle and at the apex. Some of the basal spines were .008^{mm} in length, and .003^{mm}

broad at base. They are straight, with sharply recurved and hooked extremities.

I have not yet succeeded in making out the other genital organs with entire certainty. The sections show near one of the lateral faces a number of irregular masses, which, from their striated appearance and absence of stained nuclei, I suspect to represent the convoluted vas deferens. Toward the interior of the segments these give place to irregular granular bodies from .02 to .04^{mm} in diameter, which fill the interior of the segment around the muscular cirrus sheath. These bodies evidently represent the spermatic capsules of the testes. I find no traces of even the beginning of female genitalia in these segments.

Transverse sections of the head show that the loculi are formed by a dense layer of parallel radiating fibers, which is very sharply defined from the deeper tissue of the bothria. This layer is about .05^{mm} thick at the bottoms of the loculi, but is somewhat thinner at the edges. It appears to consist of columnar epithelium. Where two loculi join, this layer of radiating fibers in each rises to form the separating costa. The transverse section of a costa therefore shows it to be composed of two layers which are confluent at the outer edge. This radiate fibrous tissue contains a few scattered granules, which, although very small, in several instances proved to be distinctly nucleated. The radiating fibers of the bothria themselves originate from a thin layer of fine fibers, which in many places seems to have separated from the tissue beneath, but which, in normal position, rests on a layer of coarse longitudinal fibers in the center of the bothria. Towards the edges of the bothria the coarse longitudinal fibers disappear and the layer of radiating fibers is succeeded by the outer granular tissue of the head, in which there are a good many longitudinal fibers.

Four principal vessels are cut by these cross-sections. Of these, two lie near the center of the head and are .015^{mm} and .02^{mm} in diameter, near the middle of the length of the head. The others are larger, oblong, and are situated near the margins. Near the middle of the head the inside diameters of one of the marginal tubes were .025 and .016^{mm}, the outside diameters .032 and .038^{mm}. These dimensions are somewhat exaggerated since the sections were carried a little obliquely through the head.

Transverse sections of the neck reveal the same alternation of muscular layers as noticed in the segment. The fascicles of the thick layer of longitudinal muscles are oblong in section and are disposed radially around the central space. This layer is interrupted for a short distance at the margins, where the granular central space is continuous with the granular layer, outside the fascicular layer.

In some sections there are three, in others there appear to be four, vessels near the margins. Two of these are larger than the others. The outer one of these two, that is, the one nearer the margin, has a definite limiting wall, while the other is more irregular in outline and

in places contains a fine granular substance. The latter vessel I take to represent the irregular longitudinal marginal vessel noticed in the living specimens, and which may be a nervous vessel.

In sections of the head the bottoms of the faces of a marginal pair of bothria lie very close together. The inner core of the head is thus very narrow, and composed mainly of coarse longitudinal fibers, with an inner granular core in which lie the aquiferous vessels. This species appears to be near *Echeneibothrium tumidulum* Rudolphi.*

The published descriptions of *E. tumidulum*, however, agree, in the main, in saying that the first segments are extremely long and narrow, and that the bothria are divided into loculi by transverse costæ and a median partition.

The former of these differences might be reconciled by supposing that the pseudo-segments of *R. cancellatum* have been taken for true segments by former describers.

The difference between the bothria of *R. cancellatum* and *E. tumidulum* is too profound to admit of reconciliation. No median row of loculi is shown in any of the published figures of *E. tumidulum* that I have seen, while in *R. cancellatum* it is very evident and could not possibly be mistaken for a median partition.

12. *Rhinebothrium longicolle* sp. nov.

[Plate VI, Figs. 1–4.]

Bothria four, marginal, linear-oblong, attached at middle point by short pedicels, ends free, margins crenulate, faces boat-shaped, deeply concave from side to side or with edges appressed, divided into loculi by about twenty-four transverse costæ and a median partition, very versatile. Neck long, slender, smooth, cylindrical, rounded posteriorly and separated from the body by a constriction. Body behind constriction a little smaller than base of neck, at first cylindrical and crossed by minute transverse lines which soon give rise to distinct segments. Segments at first very short, increasing in length uniformly, near posterior end as long as broad with posterior edge very slightly overlapping succeeding segment. Posterior segment elongated or, if contracted, with very convex margins.

Genital apertures marginal, male and female approximate. Length, 28^{mm}; breadth, $.6^{mm}$.

Habitat.—Myliobatis freminvillei, spiral valve; two specimens. Wood's Holl, Massachusetts, August 5, 1887.

This description is based on two specimens from the spiral valve of the sharp-nosed ray (*Myliobatis freminvillei*). The stomach of the host was empty and there were no other parasites found.

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* *Bothriocephalus tumidulus* Rud., *B. Echeneis* Leuckart, *Petalocephalus tumidulus* Van Lith de Jeude, *Tetrabothrium tumidulum* Rud. Dies, and *Echeneibothrium tumidulum* Beneden, Dies.

Following are the measurements of a living specimen:

	Millimeters.
Length	28.00
Length of bothria	2.00
Breadth of bothria, middle	.20
Diameter of neck near head	.16
Diameter of neck at base	.32
Diameter of constriction between neck and body	.18
Length of neck	7.00
Length of first distinct segments	.03
Breadth of first distinct segments	.40
Length of median segments	.20
Breadth of median segments	.60
Length of posterior segments	1.00
Breadth of posterior segments	.40

Measurements of median and posterior segments were made with difficulty on account of the incessant and active movements of contraction and expansion of those parts. The bothria, likewise, were in constant motion and exact measurements of them could not be obtained. The measurements given above are, however, approximately correct. In the living worm in sea-water the bothria and pedicels are yellowish white, the neck and head between the bothria, bluish white, anterior segments yellowish white, remaining segments yellowish white at center with bluish white border along each margin. The bothria were exceedingly active and they changed their position constantly. The ends of the bothria being free and the whole organ turning easily on its pedicels as on a pivot, it is therefore possible for an infinite number of positions to be assumed. While the resting position of a bothrium is that in which its long axis is parallel with the axis of the body, it is occasionally thrown forward and turned so as to lie across the top of the head at right angles to the longitudinal axis of the head. The ends of the bothria sometimes turn towards each other, sometimes they are reflexed. These movements and the resulting positions are all exceedingly graceful. The diameter of a pedicel, although variable in life, is about, .36^{mm} and the thickness of a bothrium near the pedicel about the same, .36^{mm}. When one of the specimens was put in fresh water the bothria became arcuate, their ends being reflexed, while the margins of the boat-shaped faces were closely appressed. The epidermis of the body also became loosened and in places was detached.

In fresh water and in alcohol the head and neck contract but little while the body contracts very much. In the alcoholic specimens the ends of the bothria are flexed so that the head is nearly globular.

The long, cylindrical neck of the living worm, when viewed with transmitted light, was seen to be traversed by a dark central line and by many wavy or crinkled longitudinal fibers. When moderately magnified, the dark central line appeared to lie between two inclosing dark lines, as if in a tube. The neck, while very flexible and often changing its position, was not observed to contract or expand.

One of the specimens has a crenulated marginal outline to the pos-

terior part of the body on account of the convex margins of the segments. In the other specimen the margins of the segments are not convex. The latter specimen is not so long as the other and the posterior segments do not correspond in their degree of development.

The water vascular system was plainly visible in the living specimens as rather large sinuous vessels lying a little way from each margin.

The segments are rather thick and crossed by very fine transverse lines, so that the margins of the segments when sufficiently magnified are finely crenulate. The posterior end of the last segment in one of the specimens was concave and appeared to have a fluted border. These last two features are doubtless due to the superficial layer of circular and the deeper layer of longitudinal muscles. The body, from the constriction which separates it from the neck, to the posterior segments, was, in life, very contractile, and was constantly shortening and elongating itself.

The genital apertures are marginal and situated about the middle of the segment. The vagina opens immediately in front of the cirrus. The two organs have a common external cloaca. Ova were observed escaping from the middle of a margin of one segment and from the anterior edge of another, in a specimen which was somewhat flattened under a compressor. Each ovum consisted of a hyaline envelope inclosing a granular mass. The dimensions of these living ova are: diameter of outer hyaline envelope .0279^{mm}; diameter of inner granular part .0203^{mm}.

In the alcoholic specimens these ova have undergone considerable modification. The hyaline envelope has, in most cases, collapsed and adheres to the granular interior as a closely investing membrane. This investing membrane has in most cases a very irregular outline. It has the appearance of sending out radial prolongations which are often as long as the diameter of the granular mass. In a very few cases the hyaline envelope is but little contracted. The diameters of the ova, with collapsed investing membrane, vary from .008 to .014^{mm}. The greatest diameter of an ovum with an unbroken envelope was .022^{mm}, the diameter of its granular contents being .016^{mm}. The latter is deeply stained with carmine. These ova are not free but are in a loose cluster which is held together and attached to the segment by fine interlacing hair-like fibers.

The cirrus is long and slender, and, so far as observed, without spines.

Anatomy of posterior segments.—Thin sections were made of two segments from near the posterior end of one of the specimens. The cuticle at the margins had disappeared in some places, in others it still adhered and presented a brokenly serrate outline. Beneath the cuticular layer is a thin coat of fine muscular fibers, consisting of an outer layer of circular and an inner of longitudinal fibers. This is underlaid by a coarse granular layer, and this again by a layer of coarse longitudinal fibers. The latter present a very peculiar appearance. They are surrounded by granular tissue, while many of them are char-

acterized by successive enlargements, so as to have a decidedly moniliform outline. The segments from which these sections were made were constricted at the extremities and bulging in the middle. The longitudinal fibers conformed to this subspherical shape, being straight in the vicinity of the median line and curving towards the margins.

The cirrus in these sections is seen to be long and slender and to lie in many convolutions within a cylindrical sheath which extends at least to the middle of the segment. The center of the segment is filled with large, coarse granular masses, the spermatic capsules of the testis.

The ovary is a folded or crumpled glandular organ and lies near the posterior edge. In the middle of the ovary, in two of the sections, there was a circular body, like a rosette, which is probably the shell gland.

A convoluted sinuous tube extends from the ovary along the median line. It was traced nearly to the base of the cirrus sheath where it was lost. It is probably the vagina, which in living specimens was seen to open immediately in front of the cirrus, but which was not evident in these sections. These sections did not contain any ova. The specimen from which the sectioned segments were taken was evidently immature.

The mature segments are converted into mere cases for containing ova. Apparently all the tissue of the inner part of the segment, except that which contributes to the formation of ova, is converted into fine fibrous tissue which escapes from the ruptured segments along with the ova and serves to bind them together into loose clusters. Large convoluted masses of very fine fibrous tissue were abundant in the mature segments.

SPONGIOBOTHRIUM Linton.

Characters emended.—Body articulate, tæniæform. Head separated from body by neck. Bothria four, in lateral pairs, pediceled, with crisp-folded or auriculate edges, which are crenulate and the auriculate flaps finely costate on account of a marginal row of loculi with muscular borders; unarmed and without transverse costæ on face. No myzorhynchus, no supplemental disks. Genital apertures marginal.

The crisp-folded edges of the bothria produce an effect which suggests Leuckart's *Bothriocephalus flos* (*Anthobothrium auriculatum* var. *centifolium* Dies.) The costate flaps suggest relationship to *Rhinebothrium.*

The bothria are not opposite in the sense of being cruciformly arranged, as might be inferred from the original description, but are in lateral pairs, each being, in fact, the termination of an apparently immobile pedicel.

13. *Spongiobothrium variabile* Linton.

Report of U. S. Fish Commission for 1886, pp. 462–464, Plate II, figs. 13–19.

Specific characters emended.—Head broad, appressed. Bothria four pediceled, fan-shaped, in lateral pairs, their faces and margins with numerous frill-like lobes which are sometimes gathered into a more or

less compact mass of crisp folds, sometimes expanded into long, curved auriculate or leaf-like flaps. Borders of bothria with a row of small loculi which give a crenulate outline to margins and a costate appearance to the auriculate flaps. Behind the bothria the head is quadrato-pyramidal tapering posteriorly, prolonged anteriorly into the pedicels of the bothria. Neck short. First segments short and crowded, medium and posterior segment squarish or elongated, according to state of contraction. Free proglottides four to eight times as long as broad, with irregular outlines.

Genital apertures, male and female approximate, in a marginal depression about the posterior third. Maximum length 90^{mm}.

Habitat.—Trygon centrura, spiral valve, August, 1884, July 29, 1886; four specimens on each occasion. Wood's Holl, Massachusetts.

I append the following additional data obtained from a lot of specimens collected July 29, 1886.

The specimens in this lot measured, while living, 66, 74, 82, and 90^{mm} respectively. The bothria of all were finely frilled on the edges. The head of one of the specimen measured 2^{mm} in breadth and 1.15^{mm} in thickness. The free proglottides, which accompanied these specimens, were quite active and exceedingly changeable in form. Their usual shape was elongated with the anterior end contracted into a kind of knob. The greater number of these proglottides while they were yet in the water and active burst open on one of the lateral faces. From the lataral apertures thus formed, ova and a part of the genitalia were forced out. The latter remained protruding from the lateral aperture as an ivory-white, cotton-like mass. The cirrus, which was protruded in many cases, is very long and slender.

The living ova were comparatively large. Each one consisted of a transparent globular pellicle, within which were from three to five granular masses, which seemed to be nuclei undergoing normal development. The diameter of a single ovum was $.18^{mm}$. The diameter of a single granular mass $.02^{mm}$.

A re-examination of the mature segments with the aid of thin sections enables me to add the following data regarding the anatomy. The convoluted mass of tubes in the center of the posterior segments appears densely striated in a section stained with carmine. It is evidently the vas deferens crowded with spermatozoa. In the anterior part of the section there are numerous circular patches of granular and striated tissue. The large, globular granular masses which fill the anterior two-thirds of the median segments are evidently the spermatic capsules of the testes. The cirrus is long and densely covered with spines, which appear to be easily removed from the protruded organ. The spines at the base of the cirrus are relatively long, rather slender, nearly straight, slightly recurved at the slender point and have a short basal articulation. Length of spine at base of cirrus, in one case

.016^{mm}, with diameter at base .003^{mm}; in another case, length of spines .022^{mm}, length of basal part .002^{mm}, diameter .0027 to .0036^{mm}.

The vagina is a narrow, much convoluted tube which originates between the two lobes of the ovary, in the posterior part of the segment. It follows the median line to a point on a level with the cirrus bulb, where it turns abruptly towards the margin to open immediately in front of the cirrus. Immediately in front of the inner end of the cirrus bulb it enlarges suddenly into a vaginal sinus. This vaginal enlargement, in one section, was .2^{mm} in length and .04^{mm} wide at widest part. The beginning of the narrow part appears to be lined with minute bristles. A few loose spines of the cirrus were observed in the vaginal sinus. These may have been carried over from the base of the cirrus, which lies near by, by the knife, or they may have become detached from a cirrus during copulation before the specimen was killed.

In the free proglottides with ripe ova, there is a large oval aperture on one of the lateral faces for the escape of ova. One of these oval apertures measured .4 and .3^{mm} in its two diameters. In these ripe proglottides the ova fill up almost the entire interior. The proglottides are in fact converted into mere sacs containing ova. In the alcoholic specimens the ova are small, granular, with a thin, irregular, and collapsed investing membrane. The diameter of the granular part is .02^{mm}. The ovaries are elongated oval organs occupying the posterior third of the segment, extending from the posterior end of the segment almost to the cirrus bulb.

The costate appearance of some of the prolongations of the edges of the bothria, which was alluded to and figured in the original account of this species, was not properly understood when the original description was written. It is to be accounted for, I think, in this way: When the border of a bothrium is prolonged, the prolongation will, of course, be bordered by the marginal row of loculi. As a prolongation becomes narrower, it is at the expense of that part which lies within the marginal loculi. In very narrow prolongations the row of loculi on opposite sides of the prolongation become approximated on either side of a line which is made up of the inner edges of the two rows of loculi. Such a flap when flattened out looks something like a linear pinnate leaf with a prominent midrib.

In this lot of specimens, as in the lot which furnished the basis of my former description, there are two varieties. In one the anterior and median segments are uniformly broader than long, becoming squarish toward the posterior end, the margins of the strobile crenulate. In the other the segments soon become longer than broad, slender with parallel margins, the strobile filiform with entire margins. These two forms are figured in my former paper. They probably arise from different states of contraction, but it is somewhat singular that each small lot should furnish examples of these two distinct forms.

DISCOCEPHALUM* gen. nov.

[Δίσκος, a quoit.]

Body articulate tæniæform. Head composed of two parts. The anterior part a muscular disk, which is entire or notched at the edge. The posterior part (neck), short, globose, with an inflated or corrugated surface. Neck (unsegmented part of body) much narrower than head continuous with the body. No supplemental disks. Genital apertures marginal.

This genus is established to accommodate some peculiar cestoids from the spiral valve of the dusky shark (*Carcharias obscurus.*)

No indication of true bothria nor of supplemental disks was found either in the living specimens or in preserved specimens made transparent with glycerine or oil of cloves; nor could any such indication be found in a series of sections of the head.

On account of the small amount of material and the unsatisfactory results of my study of it, I have determined to put this genus in the family *Tetrabothriidæ* for the present. If my interpretation of the homologies of this form is correct, it should be put in a new family, for which the term *Gamobothriidæ*, also suggested for the problematic genera *Lecanicephalum* and *Tylocephalum*, would be fitting.

14. *Discocephalum pileatum* gen. et sp. nov.

[Plate X, figs. 1-7.]

Head, a transversely-flattened apical disk, entire, or with a single lateral notch, followed by a much smaller, globular, inflated, cervical mass, with botryoidal or corrugated surface, yellowish in color, and separated from the apical disk by a narrow, orange-colored band, unsegmented part of body narrower than head merging into segmented body. Anterior segments very short, much crowded; subsequent segments longer than broad; mature segments irregularly squarish, very changeable in living specimen. Strobile flat, increasing in breadth uniformly to the beginning of mature segments, beyond which point it is somewhat narrower.

Genital apertures marginal a little in front of middle, male and female approximate. Cirrus long and slender, vagina opening in front of cirrus.

Length, maximum 530^{mm}; diameter of anterior disk 3 to 5^{mm}; greatest breadth of body 3 to 5^{mm}.

Habitat.—*Carcharias obscurus*, spiral valve. Wood's Holl, Massachusetts, July 19, 1886. One adult, three young.

In the single lot of specimens which furnishes the data for this description there are two distinct varieties.

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* This genus is put provisionally in the family *Tetrabothriidæ*.

They may be described briefly as follows:

Var. α.—Apical disk nearly or quite entire. Of this variety there were two specimens; one adult with ripe segments, and which, while living, measures 530^{mm} in length, diameters of anterior disk 3 and 3.5^{mm} respectively; another, a young specimen, measuring in alcohol 40^{mm} in length, diameters of anterior disk 2.1 and 2.2^{mm} respectively.

Var. β.—Apical disk large, with profound lateral notch. Of this variety there were two specimens which did not differ much in size. One of them while living measured 75^{mm} in length, diameters of anterior disc 4.5 and 5^{mm} respectively.

The following measurements of the adult specimen were obtained while it was yet living:

	Milimeters.
Length of specimen	530.00
Marginal diameter of disk	3.50
Lateral diameter of disk	3.00
Thickness of disk	1.25
Diameter of cervical mass	2.00
Breadth of unsegmented part of body	1.12
Greatest breadth of body, 115^{mm} from head	5.00
Length of segments, 115^{mm} from head	1.00
Length of posterior segments	2.45
Breadth of posterior segments	3.25
Longer diameter of ova	0.11
Shorter diameter of ova	0.08

The dimensions of the posterior segments are approximate, the segments themselves being quite variable.

These parasites were found in July, 1886, attached to the mucous membrane of the spiral valve of a dusky shark (*Carcharias obscurus*). When found they were firmly attached, the flat anterior disk being entirely embedded in the mucous membrane of the host. The only part of the head that was visible was the yellow, globular, inflated mass, behind the disk. When the worms were removed, which was effected, in each case, with some difficulty, a flat pit with a narrow opening was left in the mucous membrane.

That part which I have interpreted as the head is a muscular, compact, transversely flattened, terminal disk, which, in the adult and one of the smaller specimens (var. *α*), is slightly convex in front and concave behind, with bluntly rounded entire edges. In the larger specimen there was a very faint indication of a lateral notch on the edge of the disk. In these specimens there was no tendency to appress the sides of the disk. The head, in fact, resembled in shape a cloth-covered coat button, in which the disk represented the flat, exposed part of the button and the inflated cervical mass that part of the button by which it is fastened to the coat. In the alcoholic specimens the disk of var. *α* is convex and yellowish-white above, flat and ashy gray below. On the under side there are three or four radial slits, which are probably cracks in the cuticle, due to the effect of the preservative.

In the two remaining specimens (var. β) there is a decided notch on the edge of the apical disk. This notch is opposite a lateral face of the strobile. In one of the specimens the sides of the disk which are opposite the margins of the strobile are appressed. The apical ridge thus formed was concave in front, so that the disk was shaped like a saddle. In this case the notch was at one end of the apical ridge. In the other specimen the sides of the disk which are opposite the lateral faces of the strobile are appressed. The notch in this latter case is on one of the appressed sides of the disk. The disk in var. β is both relatively and absolutely larger than those of var. α.

With the exception of a tendency to appress the edges of the disk, which movement was accomplished slowly, no motions, either locomotile or those of dilatation or contraction, were observed in the disks of the living specimens.

Immediately behind the broad disk there is a constriction which in the living worm is marked by a narrow orange-colored band. Behind this the neck expands into a globular mass, yellowish in color and with a corrugated or fluffy surface. It is much smaller than the anterior disk, and appears to be made up of a number of inflated folds. This part was not observed to change its shape during life; its surface remained pretty uniformly corrugated. The alcoholic specimens show some irregularity, in that some of the inflated folds are much larger than others.

There was no indication of either bothria or auxiliary acetabula on either the disk or the cervical mass, although the latter, as a whole, much resembled the head of a *Phyllobothrium* in a highly contracted condition.

The body in the adult specimen (var. α), immediately after emerging from the cervical mass, increases slightly in breadth, although still quite narrow. Transverse striæ begin a short distance back of the head. The anterior segments are closely crowded together and several times as broad as long. The median segments are rectangular and three times as long as broad. The posterior segments are irregularly squarish. In the living worm the posterior segments change their shape so incessantly that it is difficult to make measurements. The strobile is flat and increases in breadth regularly from immediately behind the head to the first mature segments, from which point the breadth somewhat decreases. The mature segments are squarish, usually broader than long, but quite variable. Near the posterior end there is a tendency towards elongation, so that some segments occur which are longer than broad; others are elongated posteriorly, the posterior end becoming appressed and narrower than the anterior.

The posterior end of the mature segments are, in alcohol, dark colored on account of the ova. There is also a longitudinal dehiscent opening along the median line.

The aperture of the male genital organ is easily seen to be marginal,

usually a little in front of the middle point. The cirrus is very long and, so far as could be made out, is smooth. In order to determine the exact position of the vagina it was necessary to make an examination of thin sections.

One of the two specimens of var. β, after having lain for twenty-four hours in sea-water, measured 75^{mm} in length. For the first 35^{mm} the segments were much crowded and several times as broad as long. The posterior half consisted of segments about as long as broad. The extreme posterior segments were a little longer than broad. The posterior half of the body was much narrower than the antero-median part.

Following are measurements of the living specimens var. β. Length 75^{mm}; lateral breadth of disk, 5^{mm}; marginal breadth of disk, 4.5^{mm}; thickness of disk, 1.1^{mm}; diameter of cervical mass, 2.1^{mm}; length, 1.5^{mm}; breadth of body immediately behind head, 1.15^{mm}; thickness at same point, $.35^{mm}$; greatest breadth of body, 2.45^{mm}; length of posterior segments, 1.4^{mm}; breadth of posterior segments, 1.3^{mm}.

The strobile, particularly in the vicinity of the median segments, was very active and constantly changing its shape by alternate contraction and expansion.

The smaller specimen of var. α was not measured while living, but as an alcoholic specimen, measured 40^{mm} in length; the two diameters of the disk 2.1^{mm} and 2.2^{mm}, respectively; thickness of disk, $.96^{mm}$; diameter of cervical mass, $.86^{mm}$; length of cervical mass, $.44^{mm}$.

This specimen exhibited a phenomenon in the anterior part of the body, which, if not the result of mutilation, is a curious abnormal freak. For a distance of about 16^{mm} back of the head, beginning at the base of the cervical mass, the body is double. It appears to be double at the point where it leaves the head and where inclosed by the ruffle-like folds of the base of the organ.

A few small, slender, fusiform free segments were found associated with these worms, of which they were at first taken to be the mature proglottides. They were about 3^{mm} long and 1^{mm} broad. After a careful examination of these segments I find that they do not belong to the mature strobile, and I am disposed to regard them as belonging to some other cestod.

It is worthy of note that no parasites were obtained from this shark except the four individuals mentioned in this description, and these free segments, eight or ten in number. The only parts of the shark that were brought into the laboratory were the head and viscera. They were then identified as belonging to a specimen of *Carcharias obscurus*. I am almost tempted now to doubt the validity of the identification, since the parasites are so very different from what I have been accustomed to find in *C. obscurus*.

The cervical mass in the adult specimen was not so distinctly yellow as in the others, moreover the anterior part of the body, immediately behind it, exhibited a faint pinkish tinge, a feature which was not observed in the others.

Structure of head and neck.—A section was made through the anterior disk and carried back through the cervical mass into the anterior part of the body. The latter enters the cervical mass from behind and at first seems to be independent of it, being surrounded by the posterior frill-like lobes of that organ within the cervical mass. The anterior part of the body is seen to enlarge into a kind of central core, which in part, at least, is continuous with the anterior disk, and into which it expands.

The cervical mass while in great measure free from the anterior disk and the inner core, is in reality intimately connected with both. The disk is composed of very densely compacted muscular fibers near the exterior, with a somewhat looser texture in the central portions. The dense tissue of the exterior can be traced back into the core or central part of the cervex. A line of demarkation can be distinguished between the disk and the anterior part of the core, on the one hand, and the crisp folds of the cervex on the other, while at the posterior part of the core no such line of demarkation exists between it and the cervex. Longitudinal muscular fibers from the anterior part of the body continue into the central core, thence some radiate into the frill-like folds of the cervex, while others continue into the anterior disk, where they diverge in all directions to form the latter organ. Branches of the water-vascular system were observed in the anterior disk, the central core, and the inflated folds of the cervex. A section of the latter organ resembles a cluster of racemose glands radiating from a central core. Bundles of muscular fibers radiate from the central core to the deeply and crisply folded exterior. The tissues of this part are very loose and open, and the external folds of the surface are thin and transparent. Although no movement was observed in this organ in the living worm, it is evident from the presence, in considerable quantity, of muscular fibers and the voluminously folded surface as revealed in sections, that it is capable of great change of form. Its loose and delicate structure shows it to be, at least histologically, homologous with the crimped and folded bothria of many of the *Phyllobothrinæ.* The organ doubtless serves an analogous purpose to the bothria of such forms. Its structure shows that it is pre-eminently adapted for absorption. On the other hand the structure of the anterior disk as clearly shows it to be an organ whose chief use is to enable the parasite to adhere to its host.

Musculature of body.—The anterior part of the body, immediately behind the head, as shown in transverse sections, consists of a thick outer layer which appears to be composed, for the most part, of radiating fibers. This layer is succeded within by a narrow layer of circular fibers. The latter surrounds an elliptical central space in which there are longitudinal fibers, most abundant on its outer circumference adjacent to the circular layer. In this central space the cut ends of four aquiferous vessels are seen. These lie in pairs toward the margins. Each pair comprises a larger and a smaller vessel, lying near together, the smaller being the one which is nearer the margin.

The walls of the mature proglottides are very thin. They consist of an outer cuticular layer and an inner granulo-muscular layer. The muscular fibers in this layer are very inconspicuous.

The small amount of material at my disposal has prevented me from making as thorough examination as the importance of the subject demands.

Anatomy of proglottides.—The cirrus is exceedingly long and slender and emerges from a point a little in front of the middle of the margin. The original opening is a little in front of the cirrus. Both sexual organs have a common marginal cloaca which has a thickened muscular border.

The cirrus bulb, when the cirrus is retracted, is oblong, about .28^{mm} in diameter and .6^{mm} in length, and lies at nearly right angles to the margin. The vas deferens is a very voluminous tube which lies near the center of the segment at the base of the cirrus bulb. Some convolutions of this organ in one section were found to be .14^{mm} in diameter, or equal to one-half the diameter of the cirrus bulb. The vas deferens in this case was filled with spermatozoa.

In those segments which immediately precede the ripe proglottides, the anterior part, and indeed the greater part of the interior of the segment, is filled with granular, globular masses from .070 to .086^{mm} in diameter. These were found in longitudinal sections of segments, to be arranged in racemose clusters on branches which are transverse to the axis of the segment. These granular masses evidently represent the testes, and the branches on which they rest, ducts which communicate ultimately with the vas deferens.

Beginning at its exterior end in front of the cirrus at the margin of the segment, the vagina, a tube about .06^{mm} in diameter, passes in front of the cirrus bulb, and in front of and a little to one side of the vas deferens, to the median line of the segment. It there turns abruptly and follows the median line back to the posterior edge of the segment, where it communicates with the ovary. The latter organ is near the posterior edge of the segment. It consists of two lobes which lie symmetrically on either side of the median line. It is made up of a mass of rounded cells, some of which were found to be nucleated and were apparently unfertilized ova. The diameter of the irregular non-nuclear masses was about .013^{mm}. That of the nucleated masses, which had apparently left the ovary and were in the vicinity of the shell gland, was about .016^{mm}. An organ which I take to be the shell gland lies midway between the two lobes of the ovary, is spherical in shape and about .09^{mm} in diameter. It appears to be a somewhat convoluted tube which connects in front with the vagina and also apparently with a median groove or cleft on the face of the proglottis. Posteriorly it connects with an irregular mass which I take to be the vitelline gland. This, when magnified thirty or forty linear diameters, in a section stained with carmine, appeared as an irregular, slightly striated gland.

ular organ, which was sharply differentiated from the surrounding parts and measured .2^{mm} in length and .24^{mm} in breadth. The outlines of the uterus could not be made out from the sections but amber-colored eggs were found in clusters elongated transversely, in marginal prolongations of a median cleft of the proglottis.

In one of the mature segments ova were found that had begun to undergo segmentation. In one case four distinct cells were observed in a single ovum.

PHYLLOBOTHRIUM Van Beneden.

Body articulate tæniæform, head separated from the body by a neck, with four opposite sessile bothria, each bothrium lacinio-crispate on the margin and provided with a single ampulla-like supplemental disk. Genital apertures marginal.

The species which I refer to this genus resembles Van Beneden's *P. auricula*, but differs from it in having the bothria pediceled in marginal pairs, a feature, which, it would seem, requires the generic characters to be emended so as to admit this peculiarity.

I have referred *Phyllobothrium thysanocephalum*, of my former paper to the new genus *Thysanocephalum*, of the sub-family *Phyllacanthinæ*.

15. *Phyllobothrium foliatum* sp. nov.

[Plate VI, Figs. 5–10.]

Head broad and flat. Bothria four thin, leaf-like, sessile in marginal pairs, each pair mounted on a short, stout pedicel. Faces of bothria finely reticulated, directed forward; borders of bothria with a distinct row of loculi, and with crenulate margins. Edges of bothria more or less ruffled and folded. Each bothrium provided with a single supplemental disc on its anterior edge. Neck long, broad, and flat, immediately behind the head, quickly narrowing and becoming cylindrical, merging into the body. Segments begin as fine, transverse lines on the neck, first distinct segments very short, appearing as transverse, crowded wrinkles. Subsequent segments increase in length, becoming as long, as broad, and ultimately longer than broad. Mature segments with convex margins, appressed at the two extremities, but most at the anterior end, many of them, therefore, flask-shaped.

In alcoholic specimens, median part of body thickened and fusiform, posterior segments often elliptical, and posterior part of strobile, therefore moniliform, neck sometimes extremely attenuated.

Genital apertures marginal, near middle of margin. Cirrus echinate. Length, maximum, 185^{mm}.

Habitat.—Trygon centrura, spiral valve, August 1, 1887, very numerous. August 8, one specimen. August 10, four specimens. Wood's Holl, Massachusetts.

The following measurements are of a living specimen of the first lot: Length, 85^{mm}; breadth of head, 3^{mm}; thickness of head, 1^{mm}; greatest

diameter of face of bothrium, about 1.2^{mm}; diameter of neck, lateral, immediately behind head, 1^{mm}, a little farther back, .4^{mm}; distance to first distinct segment, about 23^{mm}; length of last segment, 1.5^{mm}, breadth, 1.1^{mm}. The longest specimens in this lot measured, while living, from 165 to 185^{mm}.

The head of the living worm in lateral view appears to be distinctly bi-lobed, and very broad. In marginal view it is quite narrow and oblong. Upon a closer examination it will be seen that what appears to be one of two marginal lobes is really a marginal pair of bothria. The latter in the living worm are capable of considerable change of form. The edges are constantly changing their outline, but are usually more or less crinkled or ruffled. This sometimes assumes an apparently ragged appearance, but in no case, so far as I have observed, are the edges of the bothria tattered.

The specimen obtained August 8, 1887, was studied while living rather more carefully than any of the others, and some features noted that were not observed in other cases. I append the following data from notes made while observing the living specimen.

The length of the specimen was 50^{mm}; length of pedicels about .4^{mm}; diameter of pedicel, lateral view, .28^{mm}; breadth of head at bases of pedicels, lateral view, .72^{mm}. Bothria thin, leaf-like sessile on the pedicel which bears each marginal pair. From the manner of their attachment it is difficult to make out their shape. At rest the pedicels point forward with an interval between equal to a little less than the diameter of a single pedicel. The bothria appeared as if bent around the end of the pedicel so that one edge curved into the space between the pedicels, while the opposite edge bent around until it touched the margin of the neck. Each bothrium bears an auxiliary acetabulum on the middle of that margin which lies next to its mate. That is, the auxiliary acetabulum of a bothrium is directly opposite to that of the other bothrium of the same marginal pair. The edges of the bothria, while at rest, project and are slighly incurved, so that the face is concave from the acetabulum to the edge opposite, while it is convex in a line at right angles to this, or, in other words, in the line which joins the two reflexed edges of the bothrium. In a state of activity the bothria effect a progressive movement by prolonging that part of the border which bears the auxiliary acetabula. When in this position the bothria are somewhat triangular, the acetabulum marking the apex of an isosceles triangle, while the base is thrown into about three folds. The edges of the bothria are not broken or laciniate, although often folded in such a manner as to present a laciniate appearance. The edges are finely crenulate, the crenulations being about .3^{mm} in diameter. The faces of the bothria are covered with hexagonal reticulations, like the surface of a honeycomb. The fibrous tissue which forms the frame-work of this reticulated surface, near the edges of the bothria, rises into parallel ribs, so that the outer rim of the thin, free edge of the bothrium, instead of being

reticulated like the remainder of the face, is divided into comparatively regular elongated loculi, about $.6^{mm}$ long and $.3^{mm}$ wide. The rounded ends of these locular cells give a crenulate outline to the edge of the bothria.

An oblong reddish patch $.2^{mm}$ in length and $.06^{mm}$ in breadth, lying transversely to the axis of the body, is situated in the head, about $.12^{mm}$ back of the apex or angle formed by the two pedicels.

On the lateral face of the head four shallow pits or pores were observed, about $.05^{mm}$ apart, along the median line. The first two were narrow, the greatest diameter, about $.12^{mm}$, transverse to the axis of the body. The third is rounder, deeper, and more evident than the others; its diameter about $.08^{mm}$.

At the apex of the head, that is, in the angle formed by the pedicels, there was a low papilla not well defined. The pedicels were marked with longitudinal rugæ.

The neck, at a distance of $.34^{mm}$ from the apex of the head, was $.64^{mm}$ broad; at the distance of 1^{mm} it was about $.4^{mm}$ in diameter. Like the head it was flat, thin, and smooth, and decreased in lateral diameter for some 4^{mm} or more back of the head. The aquiferous vessels could be seen passing up to the head and lying, two on each side, about $.1^{mm}$ from the margin. The margins of the neck outside the longitudinal aquiferous vessels seemed to be made up largely of transverse muscular tissue, and the central part of a mass of longitudinal spiral vessels. The latter are shown further on to be bundles of longitudinal muscle fibers. Transverse striæ appeared about 7^{mm} from the head. The first distinct segments were about $.04^{mm}$ long and $.4^{mm}$ broad. Towards the posterior end the segments became squarish, then longer than broad. Near the posterior end the segments grew somewhat narrower. At 10^{mm} from the posterior end the segments were $.5^{mm}$ long and $.72^{mm}$ broad; the last segment was 1^{mm} in length and $.34^{mm}$ in breadth. The posterior segments of this specimen in alcohol are elongated, with nearly parallel margins; the strobile is therefore not moniliform, as is usual in the specimens of the other lots.

The foregoing description is based on a specimen that had lain for twenty-four hours in sea-water. It was still capable of motion, and was at first rather transparent. After some two hours more the head and bothria became opaque, and the latter contracted. The measurements were made while the specimen was lying free in the water.

In the specimens of the lot collected August 1, from which the sketches of living forms were made, the red pigment spot in the head was not observed, neither were the lateral pits nor the terminal papilla, which was faintly indicated in this specimen. In the specimens collected August 10, I recorded in my notes the following observations: Head and body yellowish white, neck bluish white; last segments with large ivory-white opaque spot in the center.

The following data are from the larger lot and hence represent more general characters.

The meshes of the reticulations on the face of the bothria are about .04^{mm} in diameter. The effect of this reticulation, of the crenulated border, of the marginal row of loculi, and of the ramifications of the water vascular system on the transparent bothria of the living worm is very striking. It is a very beautiful object indeed. The loculi on the borders of the bothria in alcoholic specimens measure .05 by .07^{mm}, outside diameters, and .03 by .04^{mm} inside. The auxiliary acetabulum, while usually visible on the anterior edge of the bothria of living specimens, is often found only with great difficulty in the alcoholic specimens.

There is really no head, properly speaking. The neck simply becomes a little broader towards the anterior end and bifurcates, thus forming the two fleshy columns or pedicels which support the marginal pairs of bothria. In the alcoholic specimens the bothria are somewhat contracted and the pedicels shortened, so that the head loses something of its distinctively bilobed appearance and in lateral view appears to be transverse, making with the neck a figure like the letter T. The crenulated borders are much folded and crumpled.

The character of the neck is much the same in all as in the specimen already described, except that the four large aquiferous vessels which lie in pairs about midway between the median line and the margins are usually sinuous. In general the neck is flattened and rather broad near the head. It soon grows narrower and for some distance is nearly cylindrical. In the living specimens the surface appears to be perfectly smooth for the first 7 to 12^{mm}, at which point fine transverse lines are discernible, which a little farther on give rise to the first segments. In the alcoholic specimens, however, fine transverse lines occur immediately behind the head.

At the point where the segments begin there is, in the living worms, a slight enlargement of the neck, at which point, in some, the inner tissues of the neck appear to end abruptly in a rounded stopper-like termination, which, like the neck proper, is more transparent than the body which follows. This abrupt transition from neck to body is not so apparent in the alcoholic specimens, but in all there is a rather sudden enlargement about the point where the first segments begin.

When these worms were placed in Perenyi's fluid they contracted to nearly one-half their length in sea-water, and with few exceptions assumed a highly characteristic shape. The head is contracted, loses its forked or bilobed appearance, and viewed laterally is oblong and placed transverse to the neck. The latter is rather narrow, cylindrical for about 8^{mm}, when it enlarges rapidly and merges into the body. The maximum breadth is soon attained, and for some 12^{mm}, more or less, varying with the size of the specimen, remains of nearly uniform size. The breadth is apt to decrease slightly with the maturing segments. The latter are squarish. The specimens which have many mature seg-

ments become decidedly moniliform posteriorly, each proglottis becomes compressed anteriorly until it is reduced to a mere neck. It is also compressed, but not so much, posteriorly. The margins are therefore strongly convex. There is a tendency also on the part of some of the posterior segments to assume an arcuate form, in which one of the lateral faces is convex and the opposite one concave. Most of the alcoholic specimens are somewhat fusiform, and the last segment is elongated and compressed posteriorly as though the strobile had not yet lost any segments.

While examining the living specimens of the large lot I was for a time disposed to think that there were two species, or at least two varieties. A few appeared to be destitute of auxiliary acetabula. The heads were smaller and the bothria had thinner margins than was the case in the majority of examples. When the specimens were placed in alcohol, six out of the forty-eight individuals at once assumed a marked difference in form. The heads became flatter and thinner, somewhat flaccid, truncate in front, and wedge-shaped; the necks were much attenuated, even filiform, while the posterior end of the strobile was more decidedly moniliform than in the normal type. This difference, while quite striking, is, I think, due simply to difference in age and conditions of contraction. It is to be noted that most of the individuals with the slender necks are considerably longer than the others and have a much larger proportion of mature segments. In the one or two whose length does not exceed the average of the normal type, there is an appearance of general flaccidity as though the individuals were imperfectly developed. The difference between the two sorts with respect to the bothria is probably due to a deterioration on the part of the smaller lot, a conclusion which is further strengthened by the general appearance of maturity of the strobiles.

In the following table of measurements, Nos. 1 and 2 belong to the smaller lot, that is, those with the attenuated necks, Nos. 3 to 6 to the larger lot, or normal type. All the measurements are of alcoholic specimens:

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Length	76.00	45.00	30.00	46.00	46.00	28.00
Breadth of head	.90	1.60	1.48	1.60	1.40	1.50
Thickness of head	.36	.50	.60	.60	.70	.50
Diameter of neck near head, lateral	.28	.34	.56	.68	.50	.56
Diameter of neck at narrowest point	.08	.15	.40	.60	.40	.40
Distance to first segment	14.00	12.00	12.00	10.00	10.00	10.00
Length of first segment (approximate)	.02	.02	.02	.02	.02	.02
Breadth of first segment	1.00	.90	1.00	.80	.60	.80
Greatest breadth of body	1.00	.94	1.50	1.06	.80	1.60
Length of last segment	1.40	1.30	1.60	1.30	1.30	.80
Breadth of last segment	.90	.76	.80	.80	.70	.76

The posterior segments of corresponding degree of development in the two sorts do not differ materially in their anatomy.

Anatomy of posterior segments.—The posterior segments of the alcoholic specimens are opaque near the margins and transparent along the median region. The opacity of the marginal regions is due to great numbers of granular bodies about .03^{mm} in diameter. These marginal granular masses evidently represent the vitelline glands. The ovaries are two pale, oval organs lying one on each side of the lateral line at the posterior end of the segment. Each is about .28^{mm} long and .15^{mm} broad. In section, when highly magnified, the ovaries are seen to be made up of small polygonal cells about .005^{mm} in diameter. The vagina opens immediately in front of the cirrus. The two organs have a common external opening, situated near or a little in front of the middle of the margin. The vagina at first follows the front side of the cirrus bulb, and then continues as a much convoluted tube, in an irregularly sinuous course to its termination in a bulbous enlargement between the lobes of the ovary. An elongated and rather broad organ, appearing in section to have ruffled or lobed margins, occupies the middle of the segment, extending from the ovary nearly to the anterior edge of the segment. In longitudinal sections this organ shows a number of empty spaces and others filled with fine granules; I take it to represent the uterus, as yet destitute of ova. The vas deferens is a voluminous, convoluted tube lying near the anterior end of the segment and adjoining the base of the cirrus bulb. In sections this organ was densely and finely striated, due as I infer to the spermatozoa which fill it. No ova were found in any of the segments.

The cirrus is of moderate length. As it was retracted in every case its exact length could not be ascertained. One was estimated to be .25^{mm} in length; the diameter of the base was in one case .036^{mm}, in another .03^{mm}. Another was .38^{mm} long, diameter of base .05^{mm}, middle .027.^{mm} The cirrus bulb is pyriform, its length equal to about one-third the breadth of the segment, the large end inward. The cirrus is covered with minute, recurved spines which are about .002^{mm} in length. When highly magnified the margins of the segment are finely serrate.

Anatomy of head and neck.—Transverse sections of the head and part of the neck of a specimen stained with carmine furnished the following data:

The superficial tissue of the bothria is mainly granular. The thickened, crenulated border is composed of short radiating fibers with a few longitudinal interspersed and a layer of circular fibers as its base. Very coarse muscular fibers .005^{mm} in diameter, which originate by the splitting up of the large fascicles of longitudinal muscles of the neck, radiate from the center of the head, and constitute the predominant tissue of the two pedicels. The vessels of the water vascular system apparently originate at that part of the bothria where the edges of a marginal pair approach each other.

A transverse section of the neck near the head presents a highly characteristic appearance. The outer part consists of two thin but sharply-defined layers. The outer or cuticular layer is made up, in part, of circular and possibly of longitudinal fibers. The inner layer is also a layer of circular fibers. Within this is a somewhat indefinite, narrow region of granular material. Within this again is a very thick coat of longitudinal muscles surrounding a central space which contains the aquiferous and nervous vessels. These longitudinal muscles are collected into broad fascicles, placed side by side and standing radially around the central space. This coat is from .05 to .06^{mm} thick. These dimensions represent the breadth of the muscle fascicles. The thickness of the latter is from .008 to .016^{mm}. These masses of muscular tissue, although parallel, do not yield sections with symmetrical sides. They have, in fact, a crinkled or folded outline. The appearance of central vessels, noted in the neck of the living worm, is thus clearly explained. That appearance is caused by these bundles of longitudinal muscles. In the center of the neck they would, of course, be seen in the direction of their greatest diameter, and would therefore appear more opaque than the surrounding tissues. They would not be defined towards the margins, because there they would be seen in the direction of their least diameters, and moreover several lying in the same enfilading line of vision, they would therefore appear homogeneous.

The central space, in transverse sections, appears as two oval spaces lying toward the margins and connected at the center by a very narrow line, where the opposite lateral sides of the longitudinal muscle layer almost meet. In each marginal compartment of this central space lie the two aquiferous vessels and another, which I take to be a nervous vessel. Of the two aquiferous vessels, the one in each pair which is the nearer to the center of the neck is the larger. Each is provided with a wall .003^{mm} thick, which is very sharply defined from the surrounding granular tissue. The cross-sections of these tubes are oval, and yield the following measurements: Larger vessels, longer diameter, .027^{mm}; shorter, .019^{mm}; smaller vessels, longer diameter, .015^{mm}; shorter, .012^{mm}. The longer diameters of these sections nearly coincide with the breadth of the longer diameter of the neck. The measurements given above include the walls of the tubes.

Lying close to the marginal side of each pair of aquiferous tubes is another vessel, which I take to represent the nervous system. In transverse sections of the neck, stained with carmine, these appear at first as circular and later as oval patches, which are plainly differentiated from the surrounding tissue, but are destitute of the thick limiting walls which characterize the aquiferous tubes. These nervous channels are filled with a fine granular tissue, which is but little affected by the staining fluid, although the surrounding tissues are, without exception stained deeply. Where first observed, at the base of the head, the cross-sections of these nervous vessels was circular and .02^{mm} in diam-

eter. A little farther back they are oval, and measure .02mm and .01mm along the two diameters.*

This species is evidently near Van Beneden's *Phyllobothrium auricula* (Mem. Vers. Intest., 124, Plate XVI, 6–12), from *Trygon pastinaca.*

ANTHOCEPHALUM, gen. nov.

Body articulate tæniæform; head separated from body by neck; bothria four, unarmed, cruciformly disposed, mounted on very versatile pedicels, which contract in alcoholic specimens so as to appear sessile. Borders of bothria very flexible, crenulate, with a single supplemental disc on anterior edge; face smooth, no myzorhynchus; genital apertures marginal.

The alcoholic specimens suggest the genus *Phyllobothrium.* The distinctly pediceled bothria, however, which were quite evident in the living specimens, exclude them from that genus. The crenulate border of the bothria, which is caused by a row of small loculi, the long neck and the slender, versatile pedicels exclude them from the genus *Crossobothrium.* The immature segments of the strobile bear a strong resemblance to those of *Spongiobothrium variabile.*

16. *Anthocephalum gracile*, sp. nov.

[Plate VII, Figs. 1 and 2.]

Head in the living worm with four leaf-like, opposite bothria, mounted on very flexible pedicels. Each bothrium with a single supplemental disk on the inner anterior border, and a marginal row of small loculi. Face of bothria smooth; edges very flexible, crenulate. In the alcoholic specimens the pedicels are usually contracted, so much so, in some cases, that the bothria appear sessile. The head is then broad, subglobose; the margins of the bothria are entire, but with a tendency to lie in crinkly folds. The short-ribs which form the marginal row of loculi and the crenulate border are prominent, especially in specimens made transparent in some refractile medium. The bothria are somewhat triangular in shape, with the apices directed forward; each one, in fact, bears some resemblance to a cocked-hat.

The neck is short, subcylindrical, and merges imperceptibly into the body. The segments are at first indicated by fine transverse lines. The first distinct segments are much broader than long; next squarish, then oblong. The entire neck and body are slender, linear, and much narrower than the head. Mature proglottides not seen. Genital apertures marginal, about posterior fourth.

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*I take advantage of the opportunity afforded by the passage of the proof sheets of this paper through my hands to note that the above general observations on the musculature of this species agree in many particulars with the more detailed researches of Dr. Fritz Zschokke on *P. thridax*, in his admirable monograph on the Anatomical and Histological Structure of the Cestods. (*Recherches sur la Structure Anatomique et Histologique des Cestodes.* Mém. Inst. nat. Genév. Vol. XVII, 1888.)

Habitat.—Trygon centrura, spiral valve, two specimens; August 1, 1887, Wood's Holl, Massachusetts.

The specimens were immature. The larger afforded the following measurements while living:

	Millimeters.
Length	17.00
Length of bothria	.60
Breadth of bothria	.50
Diameter of pedicel	.14
Diameter of head at base of pedicels	.46
Diameter of neck immediately back of head	.16
Diameter 4^{mm} back of head	.12
Distance to first distinct segment	.60
Length of first distinct segment	.04
Breadth of first distinct segment	.12
Length of last segment	1.60
Breadth of last segment	.28

As the measurement $.4^{mm}$ back of the head shows, there is a slight narrowing of the body at that point. There is, in fact, a slight constriction, for the diameter immediately increases again from .12 to $.14^{mm}$. In the alcoholic specimen the breadth of the head, including the bothria, is $.8^{mm}$, the length $.6^{mm}$, diameter of the anterior part of the body $.14^{mm}$, length of posterior segment 1.16^{mm}, breadth $.3^{mm}$.

The posterior segments are not mature. They agree very nearly, however, with the median segments of *S. variabile.* The segments in question are slender, rectangular with slightly rounded angles. The ovaries lie at the posterior end of the segment on either side of the median line. The two oblong oval lobes are confluent at their posterior ends and extend forward along the margins to the vicinity of the cirrus pouch. The latter is not yet clearly defined, but enough to show that the genital apertures are marginal and situated about the posterior fourth. In front of the genital aperture the interior of the segment is filled with the globular spermatic capsules of the testis. They are about $.04^{mm}$ in diameter. Along each margin inside of the muscular wall there is a narrow space filled with small granular bodies. This space is limited on the inner side by the slightly sinuous aquiferous vessels.

The resemblance of the strobile of this species to *Spongiobothrium variabile* is so close as to lead me to suspect that it might be the young of that species. The lacinio-crispate bothria of *S. variabile* might easily be conceived to develop from the simpler leaf-like bothria of *Anthocephalum gracile.* The fact, however, that the bothria in *S. variabile* are in distinct lateral pairs, while in *A. gracile* they are almost cruciformly disposed, reveals a difference so profound that it is not only extremely unlikely that the one form should follow the other in the same individual, but is sufficient to create a just doubt as to whether that would be a true classification which would refer them to the same genus. Moreover, no supplemental disks have been discovered in *S.*

variabile while in *A. gracile* they are quite distinct in living specimens, although it must be confessed they were found with extreme difficulty in the alcoholic specimens.

ORYGMATOBOTHRIUM, Diesing.

Body elongated, articulate depressed. Head separated from body by a neck, with four opposite cup-shaped bothria, attached by a contractile pedicel, highly versatile, and each provided with two scrobiculiform supplementary disks (*auxiliary acetabula*). Genital apertures marginal. (*Diesing.*)

Van Beneden originally described the species *O. versatile* Dies. under the name *Anthobothrium musteli.* The species was taken out of the genus *Anthobothrium* by Diesing on account of the two supplemental disks on each of the bothria.

The name *Anthobothrium* was retained by Diesing, and is used in this paper, to designate those *Tetrabothriidæ* whose bothria are unprovided with auxiliary acetabula.

With regard to the supplemental disks at the center of the bothria Van Beneden says:

Upon studying these appendages (bothria) with the aid of a compressor, other characters appear which seem to be peculiar to this species. In the middle there is a circular band surrounded with fascicles of muscular fibers making a circle at the center which produces the effect of a cupping disk.

The essential generic characters of these specimens, from *Carcharias*, are about as follows:

Body elongated, articulate, depressed. Head separated from body by a neck, with four opposite cup-shaped bothria attached by short contractile pedicels, highly versatile, each provided with a single supplemental disk on anterior end of border. Border of bothria entire, without loculi. Genital apertures marginal.

In *O. crispum* (*Tetrabothrium* (*Anthobothrium*) *crispum* Molin), the second of the two species which Diesing includes in this genus, it appears to me, judging from Molin's figure, that the "central umbo" of that author, while probably of the same nature as Van Beneden's "circular band," is not to be regarded as a supplemental disk.

Whatever may be the final disposition of the genus *Orygmatobothrium* there can be little doubt of the relationship of *O. angustum* to Van Beneden's *Anthobothrium musteli.**

17. *Orygmatobothrium angustum* Lt.

[Plate VII, Fig. 3.]

Report of U. S. Fish Commissioner for 1886, pp. 468–9, Plate III, Figs. 1–3.

In the summer of 1887 I obtained this parasite of the dusky shark (*Carcharias obscurus*) on two different occasions. I give the following

* Zschokke's admirable monograph, *Recherches sur Structure Anat. et Hist. des Cestodes* (Mém. Inst. nat. Genév., Vol. XVII, 1888), which reached me before these notes were published, leaves no doubt whatever about the presence of two auxiliary acetabula on each bothrium of *Anthobothrium* (*Orygmatobothrium*) *musteli* Van Ben., and of *Orygmatobothrium longicolle* Zschokke.

emended description of the species, together with some additional data resulting from a study of living specimens:

Head, when bothria are at rest, pyramidal, bothria four, triangular or ovate, terminating in front in a narrow rounded point, broadly rounded at posterior end, with a thickened, entire border, sessile, or at least pedicels not evident. Each bothrium terminated at anterior end by a supplemental disk. Neck long. First segment squarish, subsequently longer than broad; posterior segments four or five times as long as broad and usually rounded at the extremities. Neck and segments with fine parallel, transverse furrows which give a serrate outline to margins. Genital apertures marginal, opening near anterior fourth. Length as great as 35^{mm}.

Habitat.—Carcharias obscurus, spiral valve, very abundant; July and August, Wood's Holl, Massachusetts.

The following measurements of strobile and last segment are from the living specimens:

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	35.50	32.00	17.50
Length of last segment	3.00	2.50	1.60
Breadth of last segment	0.50	0.55	0.30

The following additional measurements are from No. 3, specimen slightly flattened under the compressor: Breadth of head, anterior, .32^{mm}; breadth of head, posterior, .6^{mm}; length of neck, 2.8^{mm}; breadth, .18^{mm}; length of first distinct segment .2^{mm}, breadth, .36^{mm}.

One lot of specimens obtained August 12 contained only sixteen individuals of this species. On July 25, however, a very careful search was made for Entozoa in a dusky shark and with astonishing results. Besides several specimens of *Anthobothrium laciniatum* and *Phoreiobothrium lasium*, there were in the neighborhood of four hundred specimens of *Tetrarhynchus bisulcatus* and enormous numbers of the species under consideration. The chyle of the intestine was absolutely swarming with them. They were saved and partially assorted at the Wood's Holl laboratory. During the following winter I attempted to complete the assorting of this lot in order to find out the exact number of these parasites, but found the work insufferably tedious. The worms are in many cases felted together in a tangled mass which can not be untangled except by mutilating the strobiles. This peculiar felting together along with a kind of tough or indurated secretion was observed when the worms were first removed from their host. I have examined this unassorted lot carefully for other species, but succeeded in finding only the species mentioned above, which were separated from the lot at the time of collecting.

Desiring to form some idea of the number of individuals in this lot, I attempted to separate them from the tangle of strobiles and chyle, so

that they could be counted. I continued this work as long as my patience and the time at my disposal lasted. Upon counting the specimens that I had thus separated I found that there were one thousand nine hundred and sixty-three. In numbering the specimens I counted only the scolices. As the number was so near two thousand I returned to the work of assorting, and in a few minutes added fifty more scolices to the above number. One may therefore be very safe in saying that there were over two thousand individuals of this species in the spiral valve of this dusky shark. There yet remain several hundred specimens in the unassorted lot. The specimens of this lot vary in size from 5 to 30^{mm}. The short specimens are doubtless in most cases fragments of longer strobiles. The alcoholic specimens show a great variety of size and proportions, due to different stages of contraction. Some are slender and filiform, others so thick as to be almost wedge-shape. Between these two extremes there are a great variety of gradations.

Two distinct kinds were recognized among the living specimens. One very slender, transparent, bluish white; the other stouter, shorter, opaque, and ivory white. These differences are plainly due to different states of contraction. One of the former had the following dimensions while living: Length, 27^{mm}; breadth of neck near head, $.1^{mm}$; segments begin about 6^{mm} back of the head; length of posterior segment, 3.2^{mm}; breadth, $.32^{mm}$.

The bothria, while quite active during life, do not exhibit a very great diversity of outline. Their anterior ends frequently elongate and curve outward and back in horn-like prolongations. An opposite movement is that in which the anterior ends of the bothria are closely appressed and the broadly rounded posterior ends are curved outward and forward. These movements give to the head quite diverse outlines, but with all the flexibility of the bothria they were not observed to exhibit any tendency to crumple or become folded on the margins. In the alcoholic specimens, however, there is a tendency in the edges of the bothria to become more or less irregular in outline. Some of the specimens have the edges of the bothria slightly folded. There are no loculi along the border.

This cestod can be very easily recognized by the fine transverse furrows and ridges which give the margins of neck and segments a serrate outline. These can be seen with low magnifying powers. In some of the alcoholic specimens this feature is somewhat indistinct, as if the epidermal tissue had become loosened by the preserving fluid.

None of the posterior segments contained ova. The ovaries are rather small, paired organs at the posterior end of the segment. The vagina, originating between the ovaries as a convoluted tube, can be traced along the median line to the cirrus bulb, around which it bends like the handle of a shepherd's crook, to open beside and in front of the cirrus in a genital cloaca common to both vagina and cirrus. The latter is long and slender. It was retracted in every case, and its exact length

could not be determined. It is about .03^{mm} in diameter at base. The interior of the segments was filled with long, oval masses, which lie close together and at right angles to the long axis of the segment and along the central part of the segment on each side of the median line. In the anterior part of the segment the masses are globular, and along the margins smaller and granular.

The cirrus bulb lies in the crook of the vagina, and contains, besides the retracted cirrus, a part at least of the vas deferens. When thin sections of a stained segment were made, the cirrus was found to be covered with exceedingly minute spines. The long-oval masses in the interior of the segment now appear densely granular, or like nests of nuclei in some of the segments; in others which are more mature they are not so much elongated, and contain both nuclei and fibrous tissue.

This species is apparently near Van Beneden's *Anthobothrium musteli* (*Orygmatobothrium versatile* Dies., Revis. Ceph. Par. p. 276). I have, however, experienced the same difficulty in finding a second supplemental disk in the center of the bothria, as in the case of the specimens which furnished the material for my former description. I notice the same curved band of muscular fibres crossing the faces of the bothria about the anterior third. This does not rise into a transverse rib.

I am not at all satisfied that there is a second supplemental disk (*auxiliary acetabulum*) in this species. It is certainly very faintly outlined by the curved band of muscular fibres.*

CROSSOBOTHRIUM Linton.

18. *Crossobothrium laciniatum* Lt.†

[Plate VII, Fig. 4.]

U. S. Fish Commission Report for 1886, pp. 469–474; Plate III, Fig. 4–18.

I have already given a tolerably full account of this parasite of the sand shark (*Odontaspis littoralis*).

* In attempting to follow Diesing's system of classification of the unarmed *Tetrabothriidæ* I have experienced much perplexity, and nowhere more than among the forms kindred to those which Van Beneden has grouped under the generic name *Anthobothrium*.

The specimens which I have referred to the genus *Orygmatobothrium* possess many of the characters ascribed to the genus *Monorygma* Dies. There is, however, no myzorhynchus, unless an indistinct papilliform apical termination of the head be regarded as such.

Diesing's genera *Orygmatobothrium* and *Monorygma* are included by Van Beneden in his genus *Anthobothrium*.

† This species bears a close resemblance to Oerley's *Orygmatobothrium Dohrni: Die Entozoen der Haien und Rochen*, p. 219, pl. X, figs. 16–19, *Phyllobothrium Dohrni* Oerley,—Zschokke, *Mém. Inst. nat. Genév.*, vol. XVII, 328–338, pl. VIII, fig. 138 and pl. IX, figs. 139–144.

In the summer of 1886 and 1887 I had several opportunities of examining this shark. In each instance I found this entozoon in abundance, and usually no others. I take the following data from my memoranda made at the time of collecting:

August 2, 1886.—Eighty-one specimens of *C. laciniatum*, adult and young, obtained from the spiral valve of a single sand shark (*O. littoralis*). The chyle was swarming with mature proglottides. One individual of this lot differed from all other specimens of this parasite that I have yet seen in having a moderately elongated neck. In the normal form the neck is short and corresponds to one of the anterior segments. A description of this unusual form is given below. No other entozoon found, except a few cysts (*Xenosites* Van Beneden) in the muscular coats of the stomach and intestine.

July 13, 1887.—Seventy-five specimens of same parasite, young and adult; same host; no other entozoon found.

July 22, 1887.—Fifty-three specimens of same, maximum length 160^{mm}; same host; no other entozoon.

August 12, 1887.—Ninety-two specimens of same, mainly immature, maximum length 40^{mm}; same host; also five small *Rhynchobothria* and one Nematod.

August 13, 1887.—Forty-four specimens, mainly adult, maximum length, 125^{mm}; same host; also five Nematods, four large and one small, with their heads embedded in the mucous membrane of the stomach, near the pyloric constriction. In this lot there was an abnormal form which measured only 18^{mm} in length, but which had mature segments. This form is more fully described below.

Variety longicolle.—The abnormal form found in the lot of August 2, 1886, deserves something more than a passing notice. It is the only one of all that I have yet found that has a distinctly elongated neck. In other cases, with this single exception, the length of the neck, that is, the distance from the bases of the pedicels of the bothria to the first segment, is about equal to the length of the first segment. In other words, the segments begin immediately behind the head.

When first measured, which was after it had lain in sea-water about eighteen hours, the length of this specimen was 14.7^{mm}, the length of the neck 2^{mm}. The first segment at this time was enlarged and inflated. This latter feature disappeared in a few hours and the neck became relatively longer and thinner. After having been in sea-water for twenty-four hours, the length of the specimen was 21^{mm}, its neck 5^{mm}. There were eighteen segments in the strobile, all of which seemed to be adult and equally developed, while the last two were mature and contained ova. In this respect it was in sharp contrast with the other individuals of this and other lots, which had mature segments. These, as a rule, measured from 100 to 200^{mm} and over, in length, the anterior and median segments being immature. On the other hand, the dimensions and general appearance of the head and bothria are in no essential

particular different from the normal type. The neck, which presents the greatest apparent difference, can hardly be taken, from this isolated example, as a type for a new species. If that part of the head which lies behind the bothria in a normal individual were stretched out, which it may have the power of doing, there would then result a form of neck exactly like that which characterizes this abnormal specimen.

The absence of segments corresponding to the anterior and median immature segments of the normal individuals constitutes a difference which is much more difficult to reconcile with the typical specific characters. If other forms should be discovered answering to this, which I conceive to be an abnormal form, the discoverer would be justified in erecting a new species. It may be regarded at present as a variety.

The arrangement of the genital organs in the posterior segment is normal. The segments likewise have a lateral opening for the escape of ova. The size of the ova is the same, viz, .02 to .03^{mm} in diameter. When placed in alcohol the segments contracted very much in length, while the neck remained relatively unaffected.

Of the specimens, detailed measurements of which are given below, No. 1 is the abnormal form, No. 2 normal, here repeated for comparison. The dimensions of the abnormal specimen are those recorded when it was first measured:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	14.70	195.00
Length of head	1.00	1.45
Breadth of head	2.00	1.80
Length of neck	2.00	....
Diameter of neck, middle	.18	....
Length of first segment	.70	.50
Breadth of first segment	1.05	.70
Length of last segment	1.40	1.60
Breadth of last segment	1.23	1.90

In No. 2 no dimensions are given for the neck. The dimensions given for the first segment, however, do not differ materially from those of that part of the head which lies behind the bothria.

In the lot obtained August 13, 1887, among quite normal forms, were some which bore mature segments although much shorter than the normal strobiles. In one of these anomalous forms, measuring 18^{mm} in length, the head and first twenty segments were normal in shape and size and character of the flaps. From the twentieth to the twenty-fifth segment the breadth of the strobile increased rapidly from less than 1^{mm} to about 3^{mm}. There were thirty-six segments in all. The last ten or twelve were about the same breadth, that is, 3^{mm}, and each was about 1^{mm} in length. There were a few other specimens which were much like this one, but longer. They were, in fact, transition forms between it and the normal type.

The individuals of this species are usually an opaque, ivory-white color. A few in one of the hosts were observed to be tinged with a greenish color. This may have been due, however, to the action of some food which had been taken into the alimentary canal of the host a short time before the specimens were collected.

LECANICEPHALUM *, gen. nov.

[λεκανίς, a platter.]

Body tæniæform, articulate, head transversely flattened, circular or subquadrangular, and consisting of two disciform plates. Posterior plate with four supplemental disks (auxiliary acetabula). Neck short or none. Genital apertures marginal.

Van Beneden mentions (Poiss. des côtes Belgique, I, Parasit. et com. p. 19, Plate V, fig. 13), among the parasites of *Trygon pastinaca*, a genus which he names *Discobothrium*. The name which he gives to the species is *D. fallax*. He publishes no description of the worm, but figures the head and anterior segments. The figure is a good one, but there is no explanation of the number of times it is magnified. When, however, one is obliged to choose between a short description and a good figure in the identification of the Cestoda, the latter is to be preferred. Van Beneden's figure of *D. fallax* shows it to be a Cestod, with a thick, muscular anterior disk surmounting a quadrangular base, the angles of which are prolonged into prominent tubular bothria, the sucking-disks of which are circular.

Although I do not feel justified, from such meager data, in referring a parasite, which I have obtained on three different occasions from the spiral valve of *Trygon centrura*, to the genus *Discobothrium*, I yet find sufficient resemblance between Van Beneden's figure and my specimens to incline me strongly to the belief that they are closely related, if not generically identical. The near relationship, if not actual identity, of their hosts, makes the close affinity of these parasites the more probable.

19. *Lecanicephalum peltatum*, sp. nov.

[Plate IX, Figs. 2–4.]

Head nearly circular, disciform, and joined to the neck or anterior part of the body at the middle of the posterior side, after the manner of a peltate leaf. In the living worm the head looks like two thin plates, placed the one on top of the other. The anterior plate is almost circular with their edges, which are more or less ruffled or irregularly crenulate. In preserved specimens they are sometimes so much folded at the edges as to obscure the characteristic disciform shape. The second,

* The genera *Lecanicephalum* and *Tylocephalum* are put among the *Tetrabothriidæ* although neither genus possesses the characteristic bothria of the family. It may become necessary, upon further examination of these interesting forms, to put them in a distinct group under the name *Gamobothriidæ* or some equivalent term.

or posterior, plate is of about the same thickness as the anterior one, and, in the living specimen, is nearly circular, and bears four supplemental disks (auxiliary acetabula), which are nearly equidistant on the margin. In the alcoholic specimens, however, the posterior plate is found to be somewhat smaller than the other. Its margins are entire, smooth and quadrangular. The largest sides of the quadrangle correspond to the lateral sides of the strobile, and the supplemental disks are at the angles. In some cases the angles which bear the supplemental disks are slightly prolonged.

The supplemental disks are directed sometimes forward, sometimes backward. Their usual direction is probably outward, or at right angles to the axis of the body. The diameter of a single disk, measured in an alcoholic specimen, is .1^{mm}.

The neck, or anterior part of the body, is attached to the posterior side of the disk-shaped head, like the petiole of a peltate leaf to its blade.

Segments begin about 1^{mm}, or less, back of the head. The first distinct segments are broader than long. The segments are, at first, rather flat, squarish or rectangular, with parallel sides and sharp angles, but as the reproductive organs begin to mature, the segments become rounded and somewhat thickened, giving a moniliform outline to the strobile. The posterior segments are considerably elongated, sometimes bacilliform, rounded at the angles and slightly constricted at the ends, at other times elongated and rectangular.

Reproductive apertures marginal, a little in front of the middle of the segment. Cirrus bulb large, oval, with anterior prolongation. Cirrus echinate.

Habitat.—Trygon centrura, spiral valve, July 29, 1886, July 10, 1887, and August 1, 1887. Wood's Holl, Massachusetts.

I have obtained this entozoon on three different occasions, each time from the spiral valve of the sting ray (*Trygon centrura*), and each time but few specimens. The first lot contained but one specimen; the others four or five each.

The following measurements were made on living specimens, one from each lot:

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	8.20	12.50	14.00
Diameter of head	.90	.68	.80
Thickness of head	....	....	.40
Diameter of neck	.16	.12	.14
Distance to first distinct segment	....	.20	1.00
Length of first segment	.04	.02	.10
Breadth of first segment	.16	.12	.18
Length of last segment	.85	1.50	.80
Breadth of last segment	.30	.32	.26
Number of segments	....	60	....

In No. 1, which was lightly distorted under the compressor, the head measured across the top 1.4^{mm} and was quite thin, as shown in the sketch (Fig. 2). The dimensions of alcoholic specimens differ but little from those of the living specimens.

Although in this species the bothria, being represented by the undivided posterior disk of the head, are strictly one, the occurrence of four definite auxiliary acetabula on the margins of the bothrial disk shows its relationship to the family *Tetraphyllidæ*. The anterior plate or disk is probably to be regarded as homologous to the myzorhynchus of *Echeneibothrium*.

Although the head of *Lecanicephalum peltatum*, as a whole, is somewhat suggestive of Van Beneden's figure of *Discobothrium fallax*, the differences are also very profound. Indeed, the figure of *D. fallax* suggests some of the forms of *Echeneibothrium variabile*, especially one figured by Olsson (Lunds. Univ. Årssk., Vol. III, Plate I, Fig. 15).

Anatomy of posterior segments.—Two posterior segments were stained with hæmatoxylon and cut into longitudinal sections. They furnished the following data: The segments were about .7^{mm} in length and .24^{mm} in breadth. The body wall is composed of two layers. The outer of these is a musculo cuticular layer, which is characterized by having a transversely crackled appearance; the broken lines which produce this effect are about .01^{mm} apart. The inner layer of the body wall is coarsely granular, the granules being very irregular in shape.

The genital aperture is marginal, and in a section measuring .7^{mm} in length was exactly .3^{mm} from the anterior end. Under a low magnifying power the genital aperture appears to lead directly into a somewhat pyriform clear space, which is .16^{mm} long and .08^{mm} broad, and is directed towards the anterior end at a sharp angle. Its anterior extremity was, in one case, only .16^{mm} from the anterior end of the segment. When the sections are examined under a magnifying power of from 250 to 300 diameters, the appearance of this apparent cirrus bulb is very remarkable. It is then seen to be lined with a dense coat of very fine bristle like spines, which point towards the external aperture. The true nature of this bulb is thus revealed. It is in fact the base of the cirrus itself, and lies in a larger cavity, which also contains additional coils of the cirrus. The walls of the true cirrus bulb appear to be thin and weak in proportion to the size of the organ to be evaginated. The diameter of a section of one of the folds of the cirrus lying beside the enlarged base was .02^{mm}. The shape and appearance of the cirrus when extruded must be very remarkable. It is evidently quite long. The spines with which it is beset are quite slender and bristle-like, and measure .006^{mm} in length. The true cirrus bulb is .19^{mm} in length and .11^{mm} in breadth. It lies nearest that margin on which is the genital aperture, and in one of the sections extends to within .14^{mm} of the anterior end of the segment. The same measurement was obtained from one of the segments in which the invaginated cirrus appeared in the shape of a loop.

The ovaries are two oval or elliptical organs, .17^{mm} long and .05^{mm} broad, lying one on each side of the median line at the posterior end of the segment. They appear to be confluent at the extreme posterior end of the segment. The granular elements of which they are composed measure .005^{mm} in diameter.

A thick-walled tube originates between the lobes of the ovary, and follows the region of the median line in a sinuous course to the posterior edge of the cirrus bulb. It then turns abruptly toward the margin, where it opens into the genital cloaca behind the cirrus. This tube is evidently the vagina.

In some of the sections there are to be seen, near the vagina, what appear to be parts of a larger and convoluted tube. This I take to be the vas deferens. It differs radically in appearance from the vagina. The latter in longitudinal sections is linear; its thick walls inclose an empty space. The former is massive and filled with very fine striated material. This latter appearance, in sections of cestod segments, is occasioned by the presence of spermatozoa.

Along the margins of the segments, and in the interior among the other organs, there are numerous granular bodies. These are not always of definite shape, but are often elliptical, oval, or circular in section. They are probably sections of spheroidal masses. They are from .02 to .05^{mm} in diameter, and the granular nuclei with which they are filled are .003^{mm} in diameter. Some of these bodies, near the margins of the segment, had an incipient striated appearance. They are probably spermatic capsules of the testes, in the nuclear contents of which spermatozoa are beginning to be differentiated. There was no indication of ova in these segments.

TYLOCEPHALUM,* gen. nov.

[τύλος, a knob.]

Body articulate; head globose; bothria united into a globular disk and bearing four supplemental disks, which are arranged in lateral pairs; myzorhynchus also globose, as large as remainder of head. Neck, *i. e.*, unjointed anterior part of body, moderately long.

Genital apertures marginal (?).

I have found it necessary to establish this genus to accommodate a single small cestod from the spiral valve of the cow-nosed ray (*Rhinopterus quadriloba*). As the specimen was associated with a few specimens of *Rhinebothrium cancellatum*, I at first supposed that it might prove to be the young of that species. The total absence of anything like costæ, and, moreover, the presence of supplemental disks, at once shows that it can not be referred to either *Echeneibothrium* or *Rhinebothrium*.

* See foot-note on page 84.

The character of the head suggests a possible close relationship with *Discocephalum*. The large, globular myzorhynchus of *Tylocephalum* may be homologous with the broad, muscular head of *Discocephalum*, in which case the globular acetabular disk of the former would be homologous with the corrugated, inflated, cervical mass of the latter. If the acetabular disk of *Tylocephalum* were, in the adult, to divide into independent bothria, it would then exhibit a close resemblance to Van Beneden's *Discobothrium*.

Until more material is obtained the exact position of this Cestod must remain in some doubt.

20. *Tylocephalum pingue*, sp. nov.

[*Pinguis*, plump.]

[Plate IX, Figs. 5–9.]

Head divided into two spherical parts by a median transverse constriction, the anterior part a myzorhynchus, the posterior a bothrial disk, bearing four supplemental disks not evident in the living worm, but when the specimen is made transparent they are seen to be arranged in pairs, which are marginal with respect to the head, lateral with respect to the body.

Anterior segments begin some distance back of head, very short, much broader than long, subsequently squarish, ultimately longer than broad. Habit of body rather plump in subcylindrical. Genital apertures marginal (?). Length of immature specimen 20^{mm}.

Habitat.—Rhinoptera quadriloba, spiral valve, one specimen, Wood's Holl, Massachusetts, July 20, 1887.

The description of this genus and species is based on the examination of a single specimen. While no sexually mature segments exist the adult or strobile condition is well assured. I shall first give the description made of it while it was yet living, and then add the few observations I have been able to make after a study of the alcoholic specimens.

When the specimen was first found it was firmly attached to the mucous membrane about the middle of the spiral valve of its host. The anterior part of the head, or myzorhynchus, was imbedded in the mucous membrane. It was carefully removed without damage and the specimen placed in sea water. It then measured 20^{mm}. Its form was subcylindrical, and it had an arcuate outline on account of a flexure towards one of its margins. No movements were observed in it at first, and until it was examined with a lens it was taken to be a specimen of some *Echinorhynchus*.

The shape of the head was very peculiar, and totally unlike that of any cestod I had ever seen. In my notes made at the time I described it as shaped like a dumb-bell with a very short handle, the axis of the handle coinciding with the axis of the body. The anterior globular

part of the head, that part which was imbedded in the mucous membrane, when removed appeared to be more delicate than the posterior part. It was delicate and translucent, and of a faint pink or carnation color.

Behind the anterior tumid part of the head there was a constriction, making the handle of the dumb-bell. The band which formed this constriction was also pinkish in color. Behind this constriction was the second tumid part of the head, which was dense and opaque and of an ivory-white color. The color of the body was yellowish-white.

The head preserved its singular shape unchanged when placed in sea water, although the worm showed signs of life by very slow movements, especially of the posterior segments. The worm as a whole, however, was practically immobile, and in this respect was in sharp contrast with the very active movements of some specimens of *Rhinebothrium*, which were associated with it.

Following the head was a nearly cylindrical neck, which makes a slight but abrupt enlargement a little less than 1^{mm} back of the head. Transverse lines, which run from the margins towards the middle of the lateral faces, very soon make their appearance, but do not meet so as to divide the body into distinct segments until about 8^{mm} back of the head. The segments are at first quite short. Farther back they become squarish. Near the posterior end they are longer than broad. Four or five of the posterior segments, excepting the last one, had beautiful curving marginal outlines, being convex in front and concave behind. The last segment was considerably elongated.

The following measurements are from the living specimens:

	Millimeters.
Length	20.00
Length of head	1.16
Length of myzorhynchus	.58
Diameter of myzorhynchus	.76
Length of median constriction	.14
Diameter of median constriction	.56
Length of acetabular disk	.44
Diameter of acetabular disk	.74
Diameter of neck immediately behind head	.30
Diameter 1^{mm} back of head	.36
Length of median segments	.13
Breadth of median segments	.50
Length of segments near posterior end	.40
Breadth of segments near posterior end	.40
Length of last segment	.66
Breadth of last segment	.28

The habit of the body throughout is rather plump, inclining to cylindrical.

The specimen was further examined after it had lain some four months in alcohol. When placed in glycerine the anterior bulb of the head became transparent. Longitudinal muscular fibers could be seen enter-

ing it from behind and diverging in all directions to the periphery. The posterior bulb remained too opaque to show its structure. Immediately back of the head the neck was somewhat flattened for a short distance, beyond which it was rather plump and cylindrical. The short, flattened part of the neck was transparent, and within it could be seen a band of about ten longitudinal muscles or vessels, or both. There were no indications of reproductive organs.

The specimen was next examined in oil of cloves. The character of the head was now found to be quite different from what it had been supposed to be when studied in the living specimen. The anterior part proves to be a large globular and muscular myzorhynchus, which may possibly be retractile. The central constricted part of the head is distinct, and surrounds the compressed base of the myzorhynchus like a collar. The posterior part of the head is not strictly globular, but is longer in that diameter which corresponds to the marginal diameter of the body than it is in the opposite direction. It is entire in outline, undivided, and at its base surrounds the constricted neck like a collar. On its anterior surface it bears four supplemental disks. These are oval or oblong, in shape, and are directed forwards. They appear to be arranged in pairs, which are marginal with respect to the head, lateral with respect to the body. They are about .01^{mm} in diameter, cup-shaped, with depressed centers, in which there is a reticulated muscular tissue, and with raised edges which are composed mainly of radiating fibers.

The middle of the neck and anterior part of the body is traversed by a number of strong muscular bands of longitudinal fibers. These bands, or fascicles are distinct from certain broad sheets of longitudinal muscular fibers which can also be seen in this part of the body. The central band of fibers, or vessels, continues to be visible to the posterior end of the body.

The posterior bulb of the head is very muscular. The outer part of it is granular with radiating and circular fibers. Of these the radiating fibers predominate. Beneath this outer layer towards the center and the anterior part of the bulb there are numerous strong diagonal fibers crossing each other so as to make a net-work with rhombic meshes. The middle constricted part of the head is made up of granular tissue with very numerous radiating fibers, which enter from behind and diverge to the free collar-like border. Its center is composed of longitudinal fibers, which, entering the base of the anterior enlargement or myzorhynchus from behind, make the divergent longitudinal fibers which form the predominating fibrous tissue of that organ.

The head is thus seen to be made up of three parts: First, the myzorhynchus, which is globose in front, but contracts to a comparatively narrow base. The latter is surrounded by the anterior rim of the second part. This second or middle part of the head is short, separated from the posterior part by a deep furrow, and surrounds the base of the myzorhynchus with its anterior raised border. It may possibly be a

kind of terminal os into which the muscular proboscis can be retracted. The third part is a muscular disc, which bears four auxiliary acetabula on its anterior edge. It is truncate in front, globular in lateral, oblong in marginal view. At its base it forms a collar, with thick, rounded edges, which surrounds the abruptly-narrowed neck.

Anatomy of posterior segments.—The last three segments were stained with hæmatoxylon and cut into longitudinal sections. The segments are as yet too immature to allow one to say certainly that the genital apertures are marginal. There is, however, a dense, pyriform nuclear cluster towards the front end of each segment and nearer to one margin than the other, which I believe outlines the beginning of the cirrus bulb. There is also a nuclear aggregation at the base of each segment, which probably marks the beginning of the ovary. Although no external genital apertures as yet exist, I feel quite confident, from the appearance of these segments, that, when adult specimens of this species are found, the genital apertures will be found to be marginal.

The sections show first a soft, granular epidermis, which has a tendency to slough off. Next a fine granular layer containing delicate circular fibers. Beneath this is a layer with coarse granular and longitudinal fibers. The center of the segment is granular with no fibers of any kind. There are, however, many clusters of nuclei with a clear space in the center of the cluster. These are apparently sections of tubular bodies which are beginning to take shape in the parenchyma of the interior of the segment. Some of these nuclear clusters are elongated. Two rather prominent aquiferous vessels were observed. Each of these lies a distance from the nearest margin equal to nearly one-third the breadth of the segment. These pursued a somewhat sinuous course and passed without interruption from one segment to another.

The segments are sharply defined, the one from the other. At the dividing line between two segments an abundance of circular or transverse fibers is developed. The posterior edge of each segment projects a very little to overlap the front end of the succeeding segment.

Sub-family II.—PHYLLACANTHINÆ *Van Beneden.*

CALLIOBOTHRIUM Van Beneden.

The restoration of Van Beneden's genus *Acanthobothrium* necessitates an emendation of the definition of the genus *Calliobothrium.* The characters of this genus, thus emended, following Diesing's definition, are:

Body articulate tæniæform; head continuous with the body or separated by a neck, quadrangular, with four angular bothria, which are attached to the head in front by the dorsal face, trilocular on account of two transverse costæ, each armed in front with four simple hooks, and provided in front of hooks with a versatile supplemental disk, cup-shaped, trilocular or contracted into a globe. Genital aperture marginal.

21. *Calliobothrium verticellatum* Rudolphi.

See Report of U. S. Fish Commission, 1886, pp. 476–479, Plate IV, Figs. 1–8, for description and synonymy.

I have already published a description of this Cestod, which I obtained in August, 1884, from the spiral valve of *Mustelus canis*.

Since then I have made several captures of this parasite in the same host.

Date of capture.	No. of dog-fish examined.	Number of parasites found and remarks.
1886.		
July 22	1	A single specimen.
23	3	Several in one, one in another, none in third.
24	4	Several in each.
31	1	Twenty specimens more or less, maximum length 154^{mm}.
1887.		
July 19	6	Several from two of the hosts, maximum length 97^{mm}.
21	10	Moderately abundant in all.
Aug. 4	3	Several obtained from each.
6	1	Three specimens, maximum length 115^{mm}.
10	3	About a dozen from one, ten from another, none from third, 110^{mm} maximum.
12	1	A few specimens much attenuated and flaccid.
13	2	About forty specimens in one, nine in the other.

I add the following data to my former account of this worm. The length of the adult strobile evidently far exceeds 100^{mm}, the maximum of my former paper. The longest living specimen that I have measured was 154^{mm} in length. I also find several alcoholic specimens measuring as much as 90^{mm} in length. The free proglottides are much larger than the posterior segments of the specimens upon which I based my former description.

Following are measurements of posterior and free segments of alcoholic specimens:

	Millimeters	Millimeters.	Millimeters.	Millimeters.
Length of proglottis	5.6	4.6	3.6	5.4
Breadth of proglottis	1.3	1.4	2.2	1.3

In a living strobile, 115^{mm} in length, the last segment, when at rest, measured 3.5^{mm} in length and 1.75^{mm} in breadth. Free proglottides in the same lot were very active, in some cases stretching themselves out to a length of 10^{mm}.

The following points were made out without the aid of thin sections: The genital apertures are marginal, near, or in front of, the anterior third. There is sometimes a low papilla in the vicinity of the aperture. The cirrus is comparatively short, small and covered, at least at base, with exceedingly minute spines. It was not seen fully everted. Diameter

at base in one case about .03^{mm}. The cirrus bulb in this instance small, nearly circular in outline, and .6^{mm} in diameter. In one instance the cirrus was protruded about .044^{mm} and measured .028^{mm} in diameter. No spines were visible on the everted cirrus. In the posterior segments the ovaries occupy about the posterior fourth, and under moderate enlargement appear as finely granular organs, somewhat two-lobed, but confluent at the middle line. In segments which precede the extreme posterior ones the ovaries occupy as much as the posterior third, their anterior edge making a line transverse to the axis of the segment. The inner termination of the vagina is in a bulbous enlargement—seminal receptacle—between the lobes of the ovary. A wide duct or sinus, the uterus, occupies the median line of the segment from the ovary almost to the anterior end of the segment. The vagina leaves the uterus opposite the genital aperture and proceeds directly to the margin of the segment, thus making a right angle with the axis of the segment. The vas deferens is represented by a cluster of tubes at the anterior end of the segment. The remainder of the interior of these segments is filled with large, spherical, granular bodies, which I take to be the testes. In the mature free proglottides the anatomy is quite different from what has been given for the posterior segments. In the former an inner oblong space, the uterus, which is of considerable extent, becomes converted into an ovisac which is filled with small ova. Such a proglottis when rendered transparent in glycerine resembles a double sac. The tissue of the outer sac appears homogeneous, with the exception of a few small granular masses, which apparently represent the remnants of the testes and vas deferens. The inner sac is sharply defined from the outer by a thin limiting membrane and is filled with ova.

The foregoing points in the anatomy of the segments were confirmed by thin sections, and a few additional facts obtained. In longitudinal sections the cirrus was seen to be armed with minute spines throughout its entire length. Both the cirrus and its bulb are remarkably small in proportion to the size of the mature proglottis. The vagina was seen to open immediately in front of the cirrus. The vas deferens was found to be quite voluminous, and appeared in sections as convoluted vessels filled with a dense, filamentous substance, which I take to be spermatozoa. Some of the large, granular bodies already mentioned, were seen, in sections, to contain, besides the granular nuclei, abundant fibrous tissue. I have interpreted this as indicating the transformation of the nuclear contents of the testicles into spermatozoa. In some sections in which the uterus appeared as a broad median sinus with irregular outlines the vagina was seen to lie, not in the median sinus, but along one of its sides, within the dense, granular tissue which form the boundary walls of the sinus. This was about the middle of the segment. In some sections, however, which showed the posterior part of the segment, the vagina was seen as a convoluted tube between the lobes of the ovary, and appeared for a short time after leaving the ovary to lie in the median sinus.

The ova when highly magnified are seen to be oval and measure about .066^{mm} and .055^{mm} in the two diameters. Each ovum contained about a half a dozen globular masses, which are densely granular, stain deeply, and measure about .019^{mm} in diameter.

22. *Calliobothrium eschrichtii* Van Beneden.

[Plate VII, Figs. 5-12.]

Acanthobothrium eschrichtii Van Beneden, Bull. Acad., Belgique, XVI, II, 280.

Onchobothrium (*Calliobothrium*) *elegans*, Diesing, Sitz., der kais. Akad., XIII, 585.

Calliobothrium eschrichtii Van Beneden, Mém. Acad. Belgique, XXV, 142 and 193, Plate XIV; Diesing Revis. Ceph., Ab. Par. 280.

I have found a *Calliobothrium* repeatedly in *Mustelus canis*, which in most particulars agrees with Van Beneden's *C. eschrichtii* from *Mustelus vulgaris*. Van Beneden's description of this species is thus epitomized by Diesing:

Head subangular, bothria four, angular, subelliptical, each divided into three unequal loculi by two transverse costæ, armed in front by four simple subequal hooklets, and provided in front of hooklets with a supplemental disk (*auxiliary acetabulum*), which is sometimes simple, trilocular. Neck short. Anterior segments of the body subquadrate, subsequently longer than broad. Genital apertures marginal. Length 4 to 6^{mm}.

I find in my notes records of eight different captures of this species, each time in the spiral valve of the smooth dog-fish (*Mustelus canis*). All the captures were made at Wood's Holl, Massachusetts.

Following is a summary of the records:

Date of capture.	No. of dog-fish examined.	Number of specimens obtained and remarks.
1886.		
July 22	1	Eighteen.
23	3	Five in one host, near anterior end of spiral valve.
24	4	One in one of the four hosts.
Aug. 6	1	One.
1887.		
July 19	6	Two from one of the six hosts.
21	10	Six found in a few of the ten hosts.
Aug. 10	3	Eleven from one of the three hosts.
13	2	Two from one, and one from the other host.

These specimens were almost invariably associated with *C. verticillatum*, *Rhynchbothrium bulbifer*, and *R. tumidulum*. The same host was examined on twelve other occasions in the latter part of July and fore part of August without finding this parasite.

The length of the specimens which I have obtained varies from 5 to 14^{mm}. The average of nine specimens from the capture of July 22, 1886, is 9.56^{mm}, maximum, 14^{mm}; minimum, 6^{mm}.

The following detailed measurements were made on living specimens:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	9.00	6.00
Length of head	......	.90
Length of bothria from hooks to posterior end	.60	.64
Breadth of bothria	......	.34
Length of hooks	.20	.24
Diameter of neck	.20	.24
Length of last segment	1.00	1.00
Breadth of last segment	.60	.32

In No. 1 there were six large proglottides preceded by five smaller ones and a few indistinct ones near the head. In No. 2 there were fifteen distinct segments. The first six or eight of these were only moderately distinct, merging into fine transverse wrinkles near the head. In another specimen the five posterior segments were larger than the others and were preceded by nine smaller segments, gradually diminishing towards the head, where they merged into indistinct segments, indicated by transverse lines. The posterior segments are, in general, elongated, loosely attached to each other, and separating easily from the strobile. Usually there are from three to five mature segments. Six is the greatest number observed on a single strobile.

The greatest difference observable between these specimens and Van Beneden's *C. eschrichtii* is in respect to the dimensions of the posterior segments. The dimensions given by Van Beneden for *C. eschrichtii* are: Length, 4 to 5^{mm}; length of bothria, $.6^{mm}$; length of hooks, $.1^{mm}$; breadth of neck, $.2^{mm}$; length of free proglottis, 8 to 9^{mm}. A comparison of these measurements with those given above will show that the principal difference is that which exists between the posterior segments of my specimens and the free proglottis of Van Beneden's description.

On one occasion I found a large proglottis associated with some individuals of these species which I at first thought might prove to belong to *C. eschrichtii.* Upon comparing it carefully with posterior segments of *C. eschrichtii* and of *Rhynchobothrium bulbifer* I found that it belonged to the latter. I am therefore tempted to believe that Van Beneden has mistaken the free proglottis of some other Cestod for that of *C. eschrichtii.* I have frequently found mature segments on the longer strobiles of *C. eschrichtii*, as well as free proglottides, from which the large ova were issuing, but have never found them to exceed about 1.5^{mm} in length, while on the other hand, associated with them, I have often found specimens of *R. bulbifer* with posterior segments and free proglottides measuring 5^{mm} and 6^{mm} in length.

The description given above is perhaps enough to render identifications of this species certain, but as Van Beneden's description would indicate that there may be some constant differences between his speci-

mens and these which were obtained on this side of the Atlantic, I add the following data:

The head at rest is somewhat rectangular in outline. The bothria, four in number, are opposite, that is, not arranged in marginal pairs, oblong, rather bluntly rounded posteriorly, hollowed out on the face, boat-shaped. They are divided into three loculi by two transverse costæ. The two posterior loculi are of nearly equal length and shorter than the anterior one. At the anterior end each bothrium bears four simple hooks. These are in pairs, a pair near each margin. The bases of the hooks in each pair are closely articulated, but do not spring from a common base. The hooks are relatively long and slender, pointing backward. They curve outward slightly at first, but near the points return until they are nearly parallel with the axis of the head. The outer hook of each pair (outer with reference to bothrium) is a little longer and more slender than its mate. The inner hooks have very broad subcutaneous basal supports; a prolongation of each approaches that of the other and almost meets it. There seems, indeed, to be a small solid piece which fills up the interval between the bases. Muscular fibers can be traced to the basal supports of all the hooks. The hooks themselves when magnified are seen to be hollow and filled with finely granular material. The combined effect of these hooks is to form a crown of sixteen hooks.

In front of the hooks each bothrium is surmounted by a triangular pad which bears a single supplemental disk. This part of the bothrium is capable of considerable variation in shape. I have seen it approach the trefoil shape figured by Van Beneden, but have never seen it assume that shape definitely.

The posterior ends of the bothria are free and are susceptible of much variety of motion. In progressive movements the bothria are thrust forward either by diagonally opposite pairs, by adjacent pairs, or singly. When a specimen was placed under a compressor and slight pressure applied a bothrium was pushed forward in front of the head and attached to the cover-glass by the supplemental disk and the posterior loculus. By this means the head was dragged forward. The last part to detach itself from the cover-glass was the posterior loculus, which was acting as an independent sucking-disk. In ordinary progression the entire face of the bothrium is attached to the supporting surface. The head of the living worm is almost transparent. The bothria are strengthened by bands of muscle fibers, which lie near the margins at the bottom of the trough-like face and send up short branches to the upper edge or rim. Each bothrium is further strengthened by two transverse muscular bands, which form the characteristic costæ. A single bothrium in the living worm suggests a wire flower basket. When the posterior ends of the bothria are reflexed they are seen to be joined to the head by a broad membrane, in which lie bands of muscular fibers. When the bothria are reflexed sufficiently, that is, when their posterior

ends are turned outward and forward over the hooks, as is often the case in active worms, a short neck is revealed, which is cylindrical and lightly tumid just back of the point of attachment of the bothria. The neck or anterior part of the body is very elastic and in life contracts and expands constantly. Transverse striæ appear very soon and segments make their appearance soon after the striæ begin. A few of the first segments are broader than long. These are followed by a few which are as long as broad. The subsequent segments are longer than broad. The posterior segments are usually several times as long as broad; occasionally they are contracted until they are nearly as broad as long, often with narrow extremities.

Genital apertures marginal, about posterior third. Cirrus long and, so far as observed, smooth; vas deferens long and much convoluted. Vagina a slender tube opening in front of cirrus. Ovaries two oblong lobes lying on either side of the median line, confluent at posterior end of segment and occupying nearly the posterior third of the length of the segment. The ova are relatively large. They were frequently seen issuing from the ruptured walls of mature segments which had lain for a few hours in sea water. They are globular in shape and consist of a granular center surrounded by a thick but perfectly transparent envelope, with a very thin limiting membrane. In some the granular interior appeared to be undergoing segmentation. This segmented interior in some of the ova had assumed a stellate shape on account of prolongations of its substance, which penetrated the surrounding envelope. These prolongations were generally knobbed at the ends. Measurements of several ova which had escaped from a mature segment and had been lying for some time in water gave the following results:

	Longer diameter.	Shorter diameter.
	Mm.	*Mm.*
1	0.32	0.26
2	0.24	0.20
3	0.26	0.22
4	0.26	0.26
5	0.18	0.16

The ova evidently increase in size after being discharged from the segment, by the imbibition of water through the investing pellicle.

Van Beneden describes and figures the ova of *C. eschrichtii* as having very long filamentous appendages. While I have never seen any appearance of that kind in the ova of my specimens there does not seem to be anything inconsistent with it. The thick transparent envelope which surrounds the granular or nuclear interior might assume under certain conditions of contraction very diverse shapes.

It will be seen by the foregoing description that there are some im-

portant differences between these specimens and *C. eschrichtii.* The points of resemblance are so many, however, that I do not feel justified, at present, in making a new specific name.

ACANTHOBOTHRIUM Van Beneden.

Bothriocephali (*Onchobothrii*) spec., Rudolphi.
Calliobothrii spec., Diesing.

Body articulate tæniæform. Head separated from the body by a neck, quadrangular. Bothria four, opposite, attached to head by antero-dorsal side, each with two transverse costæ on face, and armed in front with two bifurcate hooks, and surmounted in front of hooks by a triangular pad, bearing a supplemental disk which is capable of assuming diverse forms. Genital apertures marginal.

The genus *Acanthobothrium* was established by Van Beneden to accommodate forms whose scolices resemble those of *Calliobothrium*, but which bear forked instead of simple hooks. To the genus *Acanthobothrium* he referred the species *A. coronatum* (*Bothriocephalus coronatus* Rud.), and a species which he named in honor of Dujardin, *A. dujardinii.* The former species has since been referred to the genus *Calliobothrium* by Diesing, whose classification is accepted by Von Linstow. Van Beneden's species, *A. dujardinii*, is placed in a new genus by Diesing, and is now known as *Prosthecobothrium dujardinii.*

The genus *Acanthobothrium* is thus briefly characterized by Van Beneden:

> The four bothria armed each with two hooks united at their base and forked at the apex.

I have been led to restore the name *Acanthobothrium* on account of a small species, the scolex of which agrees very closely with *A. coronatum*, and the strobile with *A. dujardinii* Van Ben. (*Prosthecobothrium dujardinii* Dies.). According to this view the species *C. coronatum* should be henceforth known as *Acanthobothrium coronatum* Rud.

Acanthobothrium paulum, sp. nov.

[Plate VIII. Figs. 1–7.]

Head subquadrate. Bothria four, opposite, oblong, faces hollowed out and boat-shaped, borders usually somewhat inflexed, with two transverse costæ, the anterior costa a little back of the middle of the bothrium, the other near the posterior end. The posterior ends of the bothria from about the anterior costa free and versatile, narrowed and bluntly rounded, each bothrium with two forked hooks at anterior end. The bases of these hooks meet on the median line of the bothrium. The inner prongs are the longer, the distance between them is about equal to the distance between two prongs of the same hook. The outer prongs bend outwards and backwards sharply. The bases of the hooks are slender, about same diameter as the prongs, and are not quite as long

as the shorter prong. They join by a simple articulation. In front of each pair of hooks is a triangular pad which bears a single, circular, supplemental disk. The neck is rather long and merges imperceptibly into the segmented body. The first segments are broader than long, but increase in length uniformly. The median segments are squarish, posterior segments longer than broad, slightly irregular in outline. In all specimens thus far observed the posterior segments are from four to eight times as long as broad. In most of the specimens, especially the shorter ones, the last segment is attenuated at the posterior end.

Genital openings marginal, near the middle of the segment. Cirrus very long when fully extended, bulbous at base when partly everted, densely echinate. Length, maximum 20^{mm}.

Habitat.—Trygon centrura, spiral valve, July, 1886; August, 1887. Wood's Holl, Massachusetts.

I have obtained this parasite on four different occasions from the spiral valve of the sting ray (*Trygon centrura*). Following is a brief summary of the different captures:

July 29, 1886; about thirty specimens from spiral valve of one ray, longest specimen about 20^{mm}.

August 1, 1887; four specimens obtained from a lot of three rays; longest specimen about 9^{mm}.

August 8, 1887; about two hundred and fourteen specimens; all quite small; maximum about 5^{mm}, from a single ray.

August 10, 1887; five specimens; maximum 13.5^{mm}, from two rays. Three of these specimens, maximum 13.5^{mm}, had black hooks. The remaining two, maximum 6^{mm}, had the ordinary amber-colored hooks. The black color, however, disappeared from the former when the specimens were placed in alcohol.

The following measurements, with the exception of the hooks of one or two specimens, were made from living specimens:

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
	mm.	*mm.*	*mm.*	*mm.*	*mm.*
Length	19.00	9.00	4.50	13.50	6.00
Length of head	....	0.60	....	....	....
Diameter of head at hooks	....	0.26	0.26	0.30	0.42
Length of bothria	0.80	....	0.50	0.80	0.64
Breadth of bothria	0.24	....	0.12	0.20	0.18
Length of hooks, maximum	0.20	0.18	0.14	0.16	0.16
Length of single prong, maximum	0.14	0.13	0.10	0.10	0.12
Diameter of neck	0.24	0.10	0.10	0.08	0.18
Length of neck	1.40	1.00	0.80	1.00	0.70
Length of first distinct segments	0.06	0.06	0.04	0.03	0.05
Breadth of first distinct segments	0.16	0.14	0.12	0.14	0.24
Length of posterior segments	1.40	1.60	0.68	1.50	1.06
Breadth of posterior segments	0.20	0.26	0.18	0.20	0.24

There is some difference between the larger specimens, 15 to 20^{mm} in length, and the smaller specimens, 4 to 6^{mm} in length, besides a difference in size. This difference, however, is confined to the region of the posterior segments, where considerable variety is to be expected in

specimens of different ages. The hooks in the smaller specimens are relatively longer in proportion to the length of the bothria than is the case in the larger specimens. In the smaller specimens the posterior segments are slender, somewhat fusiform, tapering slightly towards anterior end, more decidedly towards posterior end. In the larger specimens the posterior segments are in general linear oblong. If these differences should be found to persist in specimens with ripe proglottides they should be separated into different species.

The most conspicuous organ of the posterior segments is the cirrus. It is near the middle of the segment, and, when retracted, lies as a prominent pyriform or fusiform body near the median line. It may be seen to be densely covered with spines in specimens placed in glycerine. In specimens which measured not more than 4^{mm} in length and contained only from sixteen to twenty distinct segments the cirrus could be distinguished in the last eight or ten segments. In one of the larger specimens, about 16^{mm} in length, one of the posterior segments $.9^{mm}$ long and $.36^{mm}$ broad, somewhat flattened, the cirrus is unrolled until it is nearly as long as the segment. The spines in this instance are nearly all lost, a few patches of epidermal tissue bearing slender spines adhere to its surface. In some cases the pyriform basal part of the cirrus is protruded, and can be seen to contain the remainder of the cirrus coiled up in the interior. The spines on the basal part of the cirrus are short triangular, with broad bases and acuminate points. They are about $.005^{mm}$ in length and $.004^{mm}$ in breadth at base. The remaining spines are very slender, about $.007^{mm}$ in length and $.0005^{mm}$ in breadth.

In one segment I observed what appears to be the extremity of a very slender vagina protruding as a vulva from the margin immediately in front of the cirrus. The length of this segment was $.8^{mm}$, its breadth $.36^{mm}$; length of cirrus $.8^{mm}$; diameter at base $.08^{mm}$; at apex $.018^{mm}$. The vulva protruded $.035^{mm}$ from the margin of the segment, and was at first $.008^{mm}$ in diameter, enlarging to a funnel-shaped extremity $.035^{mm}$ in diameter.

No ova were found in any of the segments. The interior of the posterior segments is filled with the spherical spermatic capsules of the testes, about $.03^{mm}$ in diameter.

When sufficiently magnified, several bundles of longitudinal muscles can be seen in the neck near the head. A specimen that had been killed by flattening between two slips of glass and immersing in alcohol was stained with carmine, and then mounted in Canada balsam. By this means the bundles of longitudinal muscles are well differentiated. Of these there are eight; four larger median, and four smaller, the latter arranged two on each margin.

These bundles are distributed to the bothria and the anterior triangular cushions which bear the supplemental disks. Longitudinal, transverse, and diagonal muscular fibers can be distinguished in the bothria. Their arrangement can not be made out, however, on account

of the distortion resulting from compression. Behind the hooks the bothria contain a great many circular fibers, which are arranged concentrically, with the hooks as a center. Some of these concentric fibers are attached to the base of the hooks. Other fibers, also attached to the base of the hooks, cross the circular fibers radially and extend back through the bothria parallel with their long axis. Both of these sorts of fibers are exceedingly delicate. The circular muscles evidently effect the motion of circumduction or rotation in the hooks, while the radial muscles effect the motions of abduction and adduction respectively. Short, blunt processes on the under side of the hooks afford means of attachment for the muscles. These processes are on the under side of the inner prongs of the hooks. In this compressed, stained specimen the pads or cushions, which bear the supplemental disks, are emarginate posteriorly and have therefore a cordate shape. The supplemental disk measures .07^{mm} and .06^{mm} in its two diameters, inside measurement. The largest bands of muscular fibers in the neck are .048^{mm} broad, a single fiber measuring as much as .004^{mm} in breadth. The bundles of fibers in the neck can be seen plainly in specimens which have not been compressed. They are usually sinuous or waving in outline.

The smaller specimens have many characters in common with Van Beneden's *Acanthobothrium dujardinii* (*Prosthecobothrium dujardinii* Dies.), but as Van Beneden describes and figures that species as having the bothria destitute of transverse costæ, and, moreover, each provided with a posterior versatile flap, there can not be even a generic identity established between the two species. If Van Beneden's species had been based on alcoholic specimens one might suppose that he had mistaken the posterior fossette for a posterior appendage; I have seen such a deceptive appearance as this in a few alcoholic specimens. This consideration is hardly admissible, however, as Van Beneden mentions the extraordinary versatility of this posterior flap in active worms.

A. paulum differs from *A. coronatum* principally in its very much smaller size and in the different proportions of its segments.

PHOREIOBOTHRIUM Linton.

24. *Phoreiobothrium lasium* Lt.

Report of U. S. Fish Commissioner, pp. 474–476, Plate IV, Figs. 24–29.

I encountered this parasite twice in the summer of 1887 at Wood's Holl, Massachusetts, each time in the dusky shark (*Carcharias obscurus*). The first lot, collected July 25, contained nine specimens, two of them small; the second lot, collected August 12, contained fourteen specimens. Since the description which I have given for this species was based on alcoholic specimens, I add the following data obtained from living specimens:

One specimen had the following dimensions while living: Length, 32^{mm}; length of bothria, .48^{mm}; breadth, .26^{mm}; length of hooks, longest

prong, .14^{mm}; diameter of head in front, .48^{mm}; at posterior end, .62^{mm}; diameter of neck, .13^{mm}; distance to first segment, .8^{mm}; length of segment, 10^{mm} from head, .16^{mm}; breadth, .16^{mm}; length of last segment, 1.28^{mm}; breadth, .42^{mm}; number of distinct segments, sixty. The specimen was slightly flattened under the compressor.

Another specimen of the same lot was 35^{mm} in length; its last segment 1.12^{mm} in length and .5^{mm} in breadth.

The proportions of the living worm do not differ materially from those of alcoholic specimens. It was observed, however, that after they had lain for twenty-four hours in sea water the specimens were not so straight nor symmetrical as at first. The apparent varieties in preserved specimens are evidently due to different degrees of contraction. The minute epidermal spines were found in isolated patches on several of the specimens.

PLATYBOTHRIUM, gen. nov.

[πλατης, broad.]

Body articulate, tæniæform. Head decidedly flattened, squarish, or trapezohedral. Bothria four, subtriangular, sessile arranged in marginal pairs, armed with compound hooks, and each terminating posteriorly in a cup-like depression or loculus. A single indistinct circular depression (supplemental disk ?) on each bothrium in front of hooks. Genital apertures marginal.

A single specimen furnishing, as I suppose, the type of a new genus, with some characters which ally it to *Prosthecobothrium* Dies., from the spiral valve of the dusky shark (*Carcharias obscurus*), presents such decided differences from any genus included in Diesing's Revisions that I am obliged, for the present, to describe it under a new generic name. In the flattened head and marginal pairs of bothria it is unique among the armed *Phyllacanthinæ*. An objection to referring the specimen to the genus *Prosthecobothrium* is that the apparent homologue of the posterior bothrial appendage which is characteristic of that genus is, in this specimen, to be regarded rather as a loculus formed by a transverse costa near the posterior end of the bothrium, or as a kind of posterior cupping disk. Further, there is a faint indication of a single supplemental disk on each bothrium in front of the compound hooks.

Again, the doubtful character of the supplemental disk, the single or no transverse costa, and the character of the hooks exclude the genera *Calliobothrium*, *Acanthobothrium*, and *Onchobothrium*. The flattened bothria and their arrangement in marginal pairs exclude the problematical genus *Cylindrophorus* as well as *Phoreiobothrium*.

25. *Platybothrium cervinum*, sp. nov.

[Plate VIII, Figs. 8–10, and Plate IX, Fig. 1.]

Head quite flat, squarish, rhomboidal or irregularly hexagonal in outline, in lateral view; thickness less than half the breadth. Bothria

four, subtriangular in closely appressed marginal pairs. When seen from the lateral side the two bothria, which are then in view, resemble right triangles with their acute angles truncated, and so placed with reference to each other that the hypothenuses are parallel and separated by a narrow space along the median line of the head. The shorter legs of the triangles then form the antero-lateral boundary of the head and the longer legs, the postero-lateral boundary. The truncated acute angles form the apex and base of the head, respectively. There appears to be a faint supplemental disk near the anterior end of each bothrium in front of the hooks, although its identification in the alcoholic specimen is not altogether satisfactory. At the posterior end of each bothrium there is a highly characteristic modification, the exact nature of which I am not sure that I understand. In the sketches made of the living worm it appears to be a transverse costa, which is convex toward the front, lying near the posterior end of the bothrium and making a loculus in the face of the bothrium. In the alcoholic specimen, however, the appearance is somewhat different. Each bothrium appears to become somewhat tubular at its posterior extremity, and what, in the living specimen, appeared to be a posterior loculus, now seems to be the thickened tubular end of the bothrium. The inner boundary of this tubular end extends farther back than the outer boundary, so that the appearance in a specimen which had been slightly compressed would, of course, be the same as if the bothrium were crossed by a transverse costa near the posterior end. The faces of the bothrium are but little hollowed out.

Each bothrium bears near its anterior border a very characteristic set of compound hooks. The hooks showed with perfect distinctness through the transparent tissues of the head. The system of hooks on each bothrium is in three distinct parts, all of which are joined together. The arrangement of the hooks is shown in the sketches of the head. It is, in brief, as follows: Two hooklets, or rather the two prongs of a single hook, terminate the system on the inner side of the bothrium. These inner prongs are long and slender, directed backward, and lie close beside the corresponding pair in the other lateral bothrium. These prongs are terminal forks of a slender, arcuate bar, which is convex in front and articulates by means of an overlapping joint with a short, slender process, which, in turn, articulates by a plain hinge-joint with the basal prolongations of the outer set of hooklets at the marginal angle of the bothrium. This latter cluster appears at first sight to consist of three hooklets. There are in reality but two. These, like the inner hooklets, are forks of a basal part. They are long and slender, recurved, and a little larger than the inner pair. The basal part of the outer hooklets sends back a subcutaneous prolongation, which, on account of the transparency of the soft tissues of the head, looks as if it were a third prong of the compound hook. It can be easily proved to lie beneath the external coat of soft tissue. The hooklets are hol-

low, as are also the basal supports and, in fact, the whole system, with the exception of the short bar which connects the long basal support of the inner set with the shorter prolongations of the outer set.

The neck is very long and slender. No distinct segments occur until 25mm or 30mm back of the head. The first segments are squarish; the succeeding segments increase in length slowly; median segments square, becoming subcircular in outline, and towards posterior end elongated; last segments three or four times as long as broad and in life somewhat cylindrical.

Genital apertures marginal, near middle of segment, male and female approximate. Length 67mm.

Habitat.—Carcharius obscurus, spiral valve, a single specimen. Wood's Holl, Massachusetts, August 12, 1887.

The following measurements were made on the living specimen held in place by slight compression:

Length, 67mm; length of head, .52mm; greatest diameter of head, .54mm; diameter in front of hooks, .20mm; diameter, posterior, .24mm; thickness of head, .24mm; greatest breadth of single bothrium, .26mm; length of hooks, .16mm; lateral diameter of neck, .08mm; marginal diameter, .06mm; length of neck, about 16mm; length of first distinct segments, .10mm; breadth, .26mm; length of postero-median segments, .60mm; breadth, .36mm; length of last segments, 1.40; breadth, .40mm.

With regard to the occurrence of supplemental disks in this species I am in some doubt. When the living worm was first examined the sketch which my wife made of it showed that the anterior ends of the bothria were somewhat elongated and rounded, with a circular depression showing plainly in each. When I examined the specimen an hour or two later, in order to obtain measurements, the anterior ends of the bothria were abruptly truncated and there was no sign of circular depressions. Afterwards, when the worm, as an alcoholic specimen, was transferred to glycerine, something like supplemental disks were faintly visible. These are circular and about .033mm in diameter. It would appear that the anterior ends of the bothria contract or fold inward, thus obscuring the faint depression, which is probably to be regarded as a supplemental disk.

When the posterior segments were flattened out in glycerine they appeared quite regular in outline, rectangular, and somewhat confluent, so as to give to the margins of the strobile in places a gently undulating outline. None of the segments are mature. The posterior segments are filled with granular bodies about .03mm in diameter. These bodies are globular in shape in the anterior part of the segment. In the posterior part of the segment they are more irregular and collected into large elongated masses. These granular masses extend to the extreme posterior edge of the segment, while at the anterior end there is a space of clear, finely granular tissue, which extends backward along each margin between the central granular masses and the external cuticular layer.

Two of the posterior segments were stained with red and green aniline and a few additional points in the anatomy were made out. The vagina was traced from the posterior end of the segment along the median line in a straight course to about the anterior third, where it turned toward one of the margins, then back a little, and opened beside and in front of the cirrus, which, retracted in its bulb, lay in the bend of the vagina.

The cirrus bulb is oblong and apparently constantly angled or bent about the middle. That is, the cirrus bulb, from the marginal aperture, is inclined inward and backward. At about half its length it turns so that the inner end is inclined inward and forward. The length of the cirrus bulb, in one of the posterior segments, is about .22^{mm}; its diameter .055^{mm}.

When the segments were cleared up in oil of cloves the ovaries became visible at the posterior end, lying one on each side of the median line and separated from each other by the vagina, which at this point was somewhat enlarged.

THYSANOCEPHALUM, gen. nov.

Phyllobothrium, spec. Linton.

Body articulate, tæniæform. Head separated from body by neck, very small, quadrangular, with four sessile bothria, each armed with two simple hooks and provided with a single loculus in front of hooks. Neck at first slender, then expanding into a voluminous mass of lobed and crisped folds. Genital apertures marginal.

I was led into error in my original description of the Cestod upon which this genus is founded by its singularly close resemblance to Van Beneden's *Phyllobothrium lactuca* (Vers. Cestoïdes, Plate iv, Figs. 1–7). What was taken to be a rostellum, and so described by me, was present only in the smaller specimens of the lot. This so-called rostellum proves, upon subsequent examination, to be the true scolex. The sketches of this organ (see Notes on Entozoa, U. S. Fish Commission Report for 1886, Plate II, Figs. 7, 7*a*, and 7*b*) are misleading, particularly with regard to the hooks. The scolex is very small in comparison with the cervical ruff which follows it and which increases in size with the age of the strobile, while the scolex of the adult is no larger than that of young specimens.

26. *Thysanocephalum crispum* Lt.

Phyllobothrium thysanocephalum Lt., Report of U. S. Commissioner of Fish and Fisheries, 1886, pp. 464–468, Plate II, Figs. 1–12.

Scolex very small, minute when compared with the cervical ruff or pseudoscolex of an adult specimen, quadrangular in outline and provided with four oblong bothria. Each bothrium is divided about the anterior third into two loculi by a thick, transverse, chitinous (?) parti-

tion, which bears at each of its extremities a short, straightish hook. The posterior loculus is long-elliptical with irregular borders. The anterior loculus is nearly circular, with thick and nearly entire borders. The tissue of the sides and bottoms of these loculi is dense and firm. The neck immediately behind the scolex is slender, short, and cylindrical. It expands abruptly into a large, lobed, crisped, and folded mass, which, in alcoholic specimens, is more or less globose, but in living specimens may spread out into a flat, suctorial organ with fimbriated edges. This organ is so conspicuous and takes the place of bothria so effectually, particularly as the scolex appears to be missing in the larger specimens, that it may be called, with some degree of propriety, the pseudoscolex. The ratio of the diameter of the pseudoscolex to the true scolex may be from five to one, in young specimens, to thirty or more to one in adult specimens.

Behind the pseudoscolex the body is slightly flattened and longitudinally rugose. The unsegmented portion of the body is long, the segments appearing at first as transverse wrinkles, subsequently the segments decrease slightly in breadth and increase slowly in length. Near the posterior end they become squarish and at the extreme posterior end two or three times as long as broad. The ripe proglottides are easily detached and continue active for a long time after removal from the host.

Genital apertures marginal, approximate, cirrus long.

Length of strobile as much as one meter; breadth of pseudoscolex up to 15^{mm}; free proglottides as much as 8^{mm} long and 4.5^{mm} broad.

Habitat.—Tiger shark (*Galeocerdo tigrinus*), adult, half-grown, and young specimens together in spiral valve, July 23, 1885, Wood's Holl, Massachusetts.

Family IV. TETRARHYNCHIDÆ.

Subtribe *Trypanorhyncha* Diesing.

Subfamily *Phyllorhynchinæ* Van Beneden.

Subfamily I. DIBOTHRIORHYNCHINÆ.

Family *Dibothriorhynchidæ* Dies.

RHYNCHOBOTHRIUM Rudolphi.

Tetrarhynchus of authors.

Body tæniæform. Neck tubular. Head continuous with neck, with two opposite bothria, parallel or converging at the apices, lateral or marginal, entire or undivided, or, either bilocular with a longitudinal partition, or bilobed or divided. Proboscides four, terminal, filiform, armed, retractile in the neck, for the most part longer than the head. Genital apertures, male marginal, female lateral, or male and female marginal approximate.

27. *Rhynchobothrium bulbifer* Lt.

[Plate x, Figs. 8 and 9, and Plate xi, Figs. 1 and 2.]

Rhynchobothrium tenuicolle Rud., Lt., Report of U. S. Fish Commissioner for 1886, pp. 486–488, Plate v, Figs. 17 and 18.

Since publishing my first notice of this parasite, I have encountered it on several different occasions in the same host in which I first found it, viz, the smooth dog-fish (*Mustelus canis*). A careful revision of the subject in the light afforded by this additional material has convinced me that I was mistaken in referring this species to *R. tenuicolle.* I have, indeed, found it necessary to make a new specific name to accommodate it.

The species *R. bulbifer* may be briefly described as follows: Bothria two, suborbicular, but somewhat variable, with a raised and rather thick border, emarginate on posterior edge, more or less approximate in front, divergent posteriorly. The head in marginal view is therefore sagittate. Neck long, slender, subcylindrical, tapering gently for a short distance back of the head, then increasing in diameter slightly to the contractile bulbs. Immediately behind the bulbs there is a constriction, distinct in some, slight in others, behind which the neck enlarges to form a rounded or even globular base which is separated from the body by a profound constriction. The body behind this constriction is slender, subcylindrical, and for some distance is without segments or transverse markings of any kind. The first segments are rather faintly outlined; they are squarish, or even a little longer than broad; the segments increase in length towards the posterior end; the posterior segments are very large, three to four times as long as broad, rounded at the two extremities, held together feebly by narrow commissures, separating easily from the strobile. Free proglottides very active and apparently continue to grow after their release from the strobile. Proboscides very long, slender, and graceful, armed with hooks of different shapes. Proboscis sheaths slender, spiral; bulbs linear, oblong. Genital apertures marginal, usually indicated by a broad, square notch about the posterior third of the segment. Entire strobile lanceolate, with finely serrate margins and few, rarely as many as twelve, segments.

Length, 20 to 40^{mm}; length of free proglottides as much as 12^{mm}.

Habitat.—Mustelus canis, spiral valve, of frequent occurrence, July and August, Wood's Holl, Massachusetts.

Following is a list of the captures of this worm :

Date of capture.	No. of Dog-fish examined.	Number of specimens obtained and remarks.
1886.		
July 22 ...	1	Three, and free proglottides.
23 ...	3	Twenty, and free proglottides with dark colored ova.
24 ...	4	Several.
31 ...	1	Twelve.
1887.		
July 19 ...	6	Several in each.
21 ...	10	Abundant in each.
23 ...	1	Eight.
Aug. 4 ...	3	One.
6 ...	1	Two.
10 ...	3	Twelve, eleven from one host.
11 ...	2	Few.
12 ...	1	Two proglottides in bad condition.
13 ...	2	Five, two from one host, three from the other.

These specimens were associated in most cases with *R. tumidulum*, *Calliobothrium verticillatum*, and *C. eschrichtii.*

In the alcoholic specimen, of which I gave detailed measurements in a former paper, the entire length was 31^{mm}, and the length of the last segment 3^{mm}. I have since measured living specimens which differed little from the alcoholic specimens, except in the dimensions of the last segment. In one specimen, which measured 23^{mm} in length, the last segment was 3.5^{mm} in length, and a free proglottis 6^{mm} long and 2^{mm} broad. In another lot two strobiles yielded the following measurements: Length of one, 27^{mm}; length of last segment, 7^{mm}. Length of the other, 38^{mm}; length of last segment, 8.5^{mm}. Free proglottides were associated with these, which were as much as 10^{mm} and 12^{mm} in length. These are extremely active and evidently continue to grow after they have separated from the strobile.

The following detailed measurements were made of an alcoholic specimen: Length, 20^{mm}; length of head, $.44^{mm}$; diameter of head, $.50^{mm}$; diameter of neck, near head, $.24^{mm}$, middle $.20^{mm}$, base $.30^{mm}$; length of head and neck, 1.60^{mm}; distance to first distinct segments, 7^{mm}; length of first segment $.60^{mm}$, breadth $.60^{mm}$; length of last segment 3.7^{mm}, breadth $.90^{mm}$; length of proboscis 1.80^{mm}, diameter $.04^{mm}$.

The diameter given for the head is from the base in marginal view of strobile; the corresponding diameter in lateral view of strobile was $.40^{mm}$; the diameter of head near the apex is $.34^{mm}$ in both views. In my former account of this parasite there is a typographical error on page 488, where the diameter of the proboscis should read $.033^{mm}$ instead of $.33^{mm}$.

Arrangement of hooks on proboscides.—The figures published in this and the former paper give different views of the proboscides in this

species. There seems to be a considerable degree of diversity in the hooks on different sides and in different parts of the same proboscis. In general there appear to be three different styles of hooks. One kind is very minute, while of the larger and more conspicuous hooks one sort is broad and abruptly recurved, the other long and slender. The broad hooks are about .008^{mm} long and .006^{mm} wide at the base, maximum. They resemble pruning-hooks with short, stout blade. The long, slender hooks are of two kinds, one with an abruptly recurved apex, the other uniformly arcuate, tapering gradually to an acute point. The length of the long, slender hooks is about .016^{mm}, breadth at base .0027^{mm}. The arrangement of the small hooks at one point is shown in Fig. 1, Plate XI.

The distribution of the hooks appears to me to be somewhat in this wise: There is first a longitudinal series of short, broad hooks, apparently in two double rows, flanked on either side by a series of long, slender hooks with recurved points and arranged side by side in groups of three; the two latter series are separated from each other on the side of the proboscis opposite the short, broad hooks by a series of slender, arcuate hooks with other minute hooklets interspersed. Of the latter there are two longitudinal rows on either side of a row of the large arcuate hooks. Each hook in the latter row has a small hooklet situated near its base on the posterior side.

Anatomy of mature segments.—The following data were obtained from stained sections and from segments stained with carmine, hæmatoxylon, green, and red aniline respectively, and studied entire. The best results were obtained from an almost mature proglottis which had been flattened between two cover glasses, killed while in that position, stained with Beale's carmine, made transparent in oil of cloves, and studied entire. This segment was long, oval, somewhat slipper-shaped, length 6^{mm}, breadth 2^{mm}. The reproductive opening was marginal a little in front of the posterior third. The greater part of the interior was filled with roundish, granular bodies from .08 to .12^{mm} in diameter. These, when highly magnified, are seen to consist of a thick coat of dense fibrous tissue, inclosing a nest of nuclei or small granules. Behind the ovaries these granular bodies are more elongated and more closely crowded. These granular bodies, at least those which occupy the central parts of the proglottis, I take to be the spermatic capsules of the testes.

The ovary is situated near the posterior end of the proglottis and consists of two finely granular lobes, which are separated along the median line for the greater part of their length, but are confluent behind. They are surrounded on all sides in the same plane by the granular bodies mentioned above.

There are three distinct tubular organs in the interior of this proglottis, to which I give the following interpretation: First, the vagina, a comparatively large duct which appears to have its exterior opening at the margin, coincident with or immediately behind the opening of

the cirrus. From this point it can be traced towards the median line after having made a slight bend forward at the base of the cirrus bulb. It then leads to the ovaries, at the anterior end of which it enlarges abruptly and is joined to a much smaller tube, which continues in a very sinuous course to the base of the cleft between the two lobes of the ovary. A second small and very much folded tube, evidently the vas deferens, enters the inner end of the cirrus bulb at its anterior angle. From that point it can be traced forward a short distance, then back along the median line, where it lies in dense folds or plaits, nearly to the anterior edge of the ovary, where its course becomes somewhat doubtful. A third large, straight tube with thick granular walls lies along the median line from about the anterior third to a point a little in front of the ovaries; there it becomes abruptly enlarged, rounded, or pyriform and is joined by a small duct. This duct is much folded or plaited, lies between the lobes of the ovary, but extends a little way in front of the ovaries to enter the pyriform termination of the straight median duct. In some segments a round, lateral aperture was observed at a point which corresponds to the anterior termination of the median duct. In segments with ripe ova the region along the median line becomes distended with ova, which may be seen, in some at least, issuing from the lateral aperture. The ova, in some of the sections stained with carmine, are of a light amber color, oval, much collapsed, about .05^{mm} in length and .02^{mm} in breadth. In other sections there were a few ova which were apparently not yet provided with shells. They were shorter oval than the mature ova, about .035^{mm} and .024^{mm} in their two diameters, and their granular contents deeply stained. The central mass of ova in mature segments appears as a dark colored spot in alcoholic specimens, sometimes likewise in living specimens.

In stained sections the ovary was seen to be composed of polygonal, nucleated cells, about .008^{mm} in diameter. The nuclei were about .002^{mm} in diameter. Flat nucleated cells, somewhat smaller than the cells of the ovary were found in the walls of the convoluted tube which lies between the two lobes of the ovary. In sections of some of the segments the nests of nuclei, which constitute the testes, were seen to be breaking up into fine fibrillæ, presumably spermatozoa. This phenomenon was best seen in segments which had but few or no ova. In sections of segments which contained many ova there were large spaces from which the nuclear aggregations of the testes had disappeared, leaving a net-work of connective tissue. In the strands of this net-work there are occasional minute fusiform nucleated cells.

The walls of the mature segments, even those which are crowded with ova, are plentifully supplied with both longitudinal and transverse muscular fibers. These are pretty evenly distributed. The fact that the muscular tissues do not soon degenerate is also shown by the long continued vitality of the free proglottides. They continue active after lying in sea water for several hours. It is probable that they continue to grow for some time after becoming free from the strobile.

The sketch made from a living proglottis, Fig. 8, Plate X, shows the character of the cirrus bulb, the vagina, and some of the convolutions of the vas deferens. The vagina expands to form a large receptaculum seminis. This feature was indicated in sections of preserved specimens by the relaxed and folded walls of the vagina. In the figure the ovaries are obscured by the large, globular, spermatic capsules of the testes. The cirrus bulb is oblong, its inner end directed forward. It frequently protrudes in a broad, expanded collar a short distance beyond the margin of the segment. The cirrus is smooth. It is shown in Fig. 9 with spermatozoa issuing from its extremity. The spermatozoa are ejected in large quantities and appear to be felted together in elongated masses without any fluid medium.

28. *Rhynchobothrium tumidulum*, sp. nov.

[Plate XI, Figs. 3–11.]

Head with two round-oval or elliptical bothria, which are marginal or, by torsion, lateral, approximate anteriorly, widely separated posteriorly, emarginate on posterior border in life, almost entire in alcoholic specimens, very mobile. Neck variable in length according to state of contraction, but comparatively long—that is, three to five times the length of the head; in life subcylindrical, very elastic, capable of being much elongated or greatly shortened, and with a crimson spot in front of contractile bulbs. Proboscides long, slender, longer than the bothria, slightly enlarged at base; armed with minute hooklets of two kinds, one short, sharply and abruptly recurved with a broad base, the other slender, a little longer than the first kind, arcuate. Hooklets on tumid base short, and crowded in close spirals. Proboscis sheaths spiral, contractile bulbs long, slender, arcuate, sometimes decussate. Body continuous with neck, the first segments faintly outlined by transverse striæ. The first distinct segments appear at a short distance behind the contractile bulbs and are much broader than long; succeeding segments squarish, sometimes with rounded corners, soon becoming longer than broad; posterior segments several, five or more times as long as broad, often fusiform, sometimes with deep emargination at posterior end, separating easily from strobile. Whole number of segments twelve, more or less. Male genital aperture marginal, near posterior third. Length, 5 to 12^{mm}.

Habitat.—Mustelus canis, spiral valve, frequent, Wood's Holl, Massachusetts, July and August.

I have obtained this species from the spiral valve of the smooth dogfish (*Mustelus canis*) on several different occasions, but never in great numbers. It is usually associated with *R. bulbifer*, *Calliobothrium verticillatum*, and *C. eschrichtii*.

Following is a list of the captures of this worm:

Date of capture.	No. of dog-fish examined.	No. of specimens of *R. tumidulum* obtained.
1886.		
July 23	Three	Twelve.
24	Four	Five.
31	One	Two.
1887.		
19	Six	Eighteen.
21	Ten	Eight.
23	One	Two.
Aug. 4	Three	One.
10	Three	One.
11	Two	Fifteen.

Accurate measurements of the living worm are very difficult to obtain on account of the extreme variability of form due to the excessive contractility. The longest specimens measure from 10 to 12^{mm} and consist of from twelve to fourteen distinct segments. In one specimen, which measured 10^{mm} in length and had twelve segments, the last segment varied in length from 1.5 to 4^{mm}, with different degrees of contraction. The head and neck in this specimen were much contracted, and measured 1^{mm} in length. Of the twelve segments, the first four or five were very short and crowded together, the next squarish, the following ones longer than broad, the last three capable of considerable elongation. The posterior end of the last segment was deeply and abruptly emarginate. The bothria appeared to be marginal.

The following measurements are of living specimens:

Dimensions.	No. 1.	No. 2.	No. 3.
	mm	*mm*	*mm*
Length	5.20	5.40	11.60
Length of bothrium	0.26	0.30	....
Breadth of bothrium	....	0.30	....
Breadth of head	0.54	....	....
Length of head and neck	0.80	1.00	....
Diameter of neck	....	0.44	....
Length of last segment	1.46	1.30	3.20
Breadth of last segment	0.44	0.46	0.80

For No. 3 of the above table the following additional measurements are given: Length of last segment but one, 2.80^{mm}; breadth, 0.72^{mm}; distance from base of contractile bulbs to first distinct segment, 0.20^{mm}; length of first distinct segment, 0.08^{mm}; breadth, 0.36^{mm}; number of segments, 14; length of crimson spot in the contractile neck, 0.44^{mm}; length of contractile bulbs, 0.40^{mm}. The crimson spot in front of the contractile bulbs is due to the coloration of granules in the parenchyma of the neck. It is quickly dissolved by alcohol.

The bothria are very mobile in life, being sometimes turned forward so as to present two cupping dishes directly in front; at other times both are turned over so as to be applied to the same surface, when they act as suctorial discs to aid the worm in locomotion. The edges of the bothria are somewhat thickened, the face hollowed out and the posterior margins emarginate. This latter feature is retained in but few of the alcoholic specimens, and in them usually with not much distinctness.

On two different occasions I have observed what I am disposed to interpret as embryos which have escaped from the ova before leaving the mature segments. They presented exactly the same character on each occasion. They are long ovate, or rather conical, broadly rounded at one end, tapering to a point at the other, with a few clusters of curved bristle-like spines at the smaller end, and near the larger end. They were first noticed in the summer of 1886, when they were seen, along with undoubted ova, issuing from living segments in sea-water. They measured .055^{mm} in length and .023^{mm} in diameter near larger end, while the length of the bristles was about .012^{mm}. The ova were about the same length as these bristle-bearing embryos and twice as broad. In July, 1887, while examining some specimens of this rhynchobothrium which had been placed in sea water under a compressor, I observed multitudes of these highly characteristic objects. They were .048^{mm} in length and .016^{mm} in breadth at larger end. It was observed that segments of this worm, after lying for a few minutes in sea water, burst at irregular places, allowing the escape of these embryos. Along with these conical bodies were great numbers of small globular masses .0076^{mm} in diameter. The latter were highly refractile and contained two or three, sometimes more, nuclear granules. They probably come from a layer of roundish granular bodies which lie beneath the muscular walls of the segment. In a few instances the wall of a segment was observed to swell out into one or more bud-like prominences from which the embryos and the small refractile bodies presently burst forth. The embryos, after having been discharged for about an hour in sea water, changed from a transparent or translucent white to a very dark brown or black. My attention was first called to this fact by noticing patches of some black substance in the bottom of a dish of sea water in which a number of these worms had been placed. Upon examination these patches proved to be made up of these characteristic embryos, but most of them quite black. A few were unchanged, or but little changed. In the dark-colored ones the bristle-like spines are much more distinct than in the colorless ones. This is doubtless due to the change of color which affects the bristles as well as the rest of the object, making them opaque. These spines are now seen to be strongly curved, to occur at the smaller end and also in a ring of irregular bunches near the larger end. No movements were observed in any of

these objects. An examination of the alcoholic specimens has resulted in finding several of these embryos clinging by their spines to the proboscides and other parts.

Thin longitudinal sections were made of a mature segment, the anterior half and more of whose interior was dark colored from the presence of ova. The sections show that the anterior part of the segment is a veritable egg-sac. Instead of ova with definite outlines, however, it seems to contain nothing but a mass of collapsed egg-shells or cases of a yellowish-brown color. In two or three cases I was able to make out irregular conical outlines which agree in shape and size to the free embryos. I saw nothing which I could certainly identify as embryos.

Anatomy of mature segments.—My investigations on the anatomy of the posterior segments have as yet been rather unsatisfactory. The cirrus, which was not seen everted, appears to be short and smooth, and in one instance was about .03^{mm} in diameter. The cirrus bulb is oval and lies nearly at right angles to the axis of the segment. In segments which do not contain ova the ovaries can be seen at the posterior end as comparatively small paired organs, while the remainder of the interior of the segment, except so much as is occupied by the cirrus bulb, is filled with oblong testicular bodies, which lie close together, at right angles to the axis of the segment and in two longitudinal rows, one on each side of the median line. These are separated from the marginal walls by a row of smaller, roundish granular masses. In the stained sections which I have thus far prepared there are but few traces of tubular organs or ducts. A rather large convoluted mass lies in front of the ovaries which may represent the vas deferens. A tubular vessel, somewhat folded or sinuous, could be seen leading from the vicinity of the ovary forwards along the median line. I infer from the disposition of such parts as I can make out that the vagina opens marginally beside the cirrus. In front of the cirrus a space along the median line becomes modified into a capacious uterus with, at first, sacculated walls, but which ultimately comes to occupy all the anterior two-thirds of the segment.

The following dimensions of proboscides and hooks may be of assistance in future identifications:

	Base.	Middle.
	mm.	*mm.*
Diameter of proboscis, exclusive of hooks	0.022	0.019
Length of hooks	0.006	0.008
Distance between spirals	0.008	0.014
Number of hooks visible in one spiral	12	12

This species seems to be near *R. rubromaculatum* Dies. (*Tetrarhynchus Trygonis pastinaceæ* Wagener.)

29. *Rhynchobothrium hispidum*, sp. nov.

[Plate XI, Figs. 12–17.]

Bothria two, lateral, entire, subelliptical, edges elevated, face hollowed out to form a cupping-disk, widely separated posteriorly, somewhat approximate anteriorly. Neck relatively long, wider than first segments, subcylindrical, very contractile, with two small crimson spots immediately in front of the contractile bulbs; when highly magnified seen to be densely covered with minute short bristles. Proboscides very long, slender, armed with hooks of two principal sorts, one sort short, sharply recurved and very broad at the base, the other sort slender and arcuate, but stouter than those of *R. tenuispine*, and not so close together. First two segments short, squarish, indistinct, broader than long, third segment about as long as the first two, fourth segment about as long as the second and third, remaining segment increasing in length, last segment very much longer than broad. Whole number of segments about six. Posterior segments separating easily, usually very long and slender and somewhat fusiform. Genital apertures, male marginal, about posterior third. Length from 4 to 8^{mm}.

Habitat—Trygon centrura, spiral valve, July and August. Wood's Holl, Massachusetts.

At different times during the past two summers I have found some exceedingly small *Rhynchobothria* in the spiral valve of the sting-ray (*Trygon centrura*), the most of which were characterized by having two small red spots in the substance of the neck in front of the contractile bulbs. It has so happened that I have obtained several other more conspicuous forms at the same time, so that these smaller forms have never been studied carefully while living. Upon examining the alcoholic specimens I find it necessary to separate these small *Rhynchobothria* into three distinct species on account of the profound difference in the style of hooks. These species bear a close resemblance to Van Beneden's *Tetrarhynchus minutus* from *Squatina angelus*, but differ from it in having the crimson spots in the neck. Van Beneden, furthermore, represents his species as having the bothria profoundly bilobed and the hooks, according to his figure, of uniform size. The species *R. tenuispine* resembles *R. heteromerum* Dies. in some particulars. The resemblances and differences are mentioned under the description of *R. tenuispine*.

R. longispine may prove to be a variety of *R. hispidum*.

I have found *R. hispidum* on three different occasions as follows:

Date of capture.	No. of rays examined.	No. of worms found.
July 29, 1886	One	Twelve.
Aug. 1, 1887	Three	Many.
Aug. 10, 1887	Two	Two small.

It was found almost impossible to make satisfactory measurements of living worms on account of their great activity and consequent extreme variability. In the following measurements of living specimens the dimensions of the head, neck, and length of strobile are approximate:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	4.50	7.80
Length of bothria	0.20	0.16
Breadth of head	0.45	0.34
Length of neck	1.00	0.80
Breadth of neck	0.16	0.20
Length of contractile bulbs	0.60	0.46
Breadth of contractile bulbs		0.04
Length of first segment	0.08	0.06
Breadth of first segment	0.16	
Length of last segment	1.10	3.60
Breadth of last segment	0.16	0.46
Number of segments	5	6

The following additional measurements of No. 2 are given to show the proportions of the segments: Length of first segment, .06^{mm}; second, .10^{mm}; third, .26^{mm}; fourth, .70^{mm}; fifth, 2.10^{mm}; sixth, 3.60^{mm}.

The following measurements are of alcoholic specimens:

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Length	4.00	4.20	4.40	4.00
Breadth of head	0.30	0.24	0.28	0.26
Length of head and neck	1.20	1.10	1.30	1.20
Breadth of neck	0.20	0.20	0.20	0.24
Length of contractile bulbs	0.56	0.56	0.64	0.50
Length of first segment	0.06	0.04	0.06	0.05
Breadth of first segment	0.17	0.15	0.12	0.16
Length of third segment	0.16	0.12	0.14	0.14
Breadth of third segment	0.14	0.14	0.11	0.14
Length of fourth segment	0.36	0.30	0.34	0.32
Length of last segment	1.40	2.10	1.60	1.40
Breadth of last segment	0.20	0.16	0.14	0.22
Number of segments	6	6	6	6

The first segment is here reckoned from the base of the contractile bulbs to the first transverse line. The second segment has about the same dimensions as the first. In specimens that are in glycerine the segments are somewhat opaque, while the neck and head are quite transparent.

Only one of the alcoholic specimens had more than six segments. It had about eight distinct segments, which were more rounded, bead-like, and shorter in proportion to the length than in the others. The last segment is not so long in proportion to the others. The proboscides were retracted and the hooks could not be seen plainly, but the specimen is apparently the same species as the others.

One free segment, alcoholic, measured 2.6^{mm} in length, 0.22^{mm} in breadth at anterior end, 0.16^{mm} at posterior end, and 0.32^{mm} at posterior third at the genital aperture.

Many of the alcoholic specimens have the proboscides everted as much as $.7^{mm}$, or more than three times the length of the bothria. Their diameter is about $.02^{mm}$, exclusive of hooks; greatest diameter observed from tip to tip of hooks, $.04^{mm}$.

The character and arrangement of the hooks is shown in the sketches. There is a single longitudinal row of short hooks with very broad bases. On each side of this row there is a series of about four rows of long slender hooks, and on the opposite side of the proboscis a series of about five small slender hooks. There is considerable variety in shape and size of the slender hooks. The broad hooks are recurved at the point and widen rapidly towards the base, at which there is a prominent posterior prolongation, which makes the length of the base exceed the length from base to apex. One of the broad hooks measured $.011^{mm}$ in length, while the breadth of the base was $.016^{mm}$; another $.008^{mm}$ in length was $.011^{mm}$ broad at base. The hooks are larger at the base of the proboscis than they are at the apex. The slender hooks present rather more variety in size, if not also in shape, than the broad hooks. In general they are somewhat longer than the broad hooks, slender, tapering uniformly to the point and slightly recurved or arcuate. They also become smaller towards the apex of the proboscis. One of the largest measured $.013^{mm}$ in length and $.004^{mm}$ in breadth at base.

The ova, which were seen issuing from the posterior segment of a living specimen under the compressor, measured $.025^{mm}$ in diameter. They consist of a thin, fragile hyaline shell surrounding a clear space in which is a granular nucleus.

The last segment in the largest specimen contained mature ova. The last but one is characterized by having the greater part of the interior filled with rather large, oblong, or squarish masses, which lie in two longitudinal rows on either side of the median line. The median and anterior parts of the segment are filled with ova.

The male genital aperture is marginal and near the posterior third. The segment usually has its greatest diameter in the vicinity of the genital aperture. In one segment a smooth, slender cirrus was extruded from the center of a wide marginal sinus. I have not yet succeeded in demonstrating the position of the vaginal aperture. The posterior segments in alcoholic specimens are often arcuate.

30. *Rhynchobothrium longispine*, sp. nov.

[Plate XI, Figs. 18–20.]

Head short and broad. Bothria two, marginal (?), suborbicular, widely separated; neck rather long, broader than first segments; proboscides long, slender, and armed with relatively large, prominent hooks;

sheaths spiral; contractile bulbs long, slender, and parallel. First segments rectangular, broader than long; subsequent segments increasing in length rapidly; posterior end of last segment emarginate.

Genital aperture of male marginal, about posterior third. Species near *R. hispidum*, but with relative longer and larger hooks on proboscides.

Habitat.—*Trygon centrura*, spiral valve, July, 1886; August, 1887; Wood's Holl, Massachusetts.

In two lots of small *Rhynchobothria* which were distinguished at the time of collecting by their small size and the occurrence, at least in a majority of them, of two red spots in the neck, in front of the contractile bulbs, and which were found to be made up for the most part of the two species *R. hispidum* and *R. tenuispine*, there were two very small individuals which I am obliged to refer to a distinct species. These specimens have lost the posterior segments. The description given rests mainly on the characters of the bothria, proboscides, neck, and first segments. It is probable that there are red pigment spots in the neck as in the two associated species, but this can not be affirmed certainly, since the specimens were not separated from *R. hispidum* until after they had been for some time in alcohol.

The short and broad character of the head may not be true for the living specimens, since the bothria are doubtless mobile. It is to be observed, however, that the shape of the heads of these two specimens is unique when compared with the alcoholic specimens of *R. hispidum*, although individuals of that species were observed to assume positions while living that were much like that which characterizes *R. longispine*.

In the larger specimen of the two the first two segments are rectangular, broader than long, the third is nearly square, the fourth is considerably longer than broad, while the fifth and last is as long as all the preceding segments taken together; its posterior end is emarginate. The smaller specimen differs from the larger only in having three instead of five segments.

The principal difference between this species and *R. hispidum* is in the hooks. These, at least near the base, appear to have the following arrangement: There is first a longitudinal row of broad, stout, abruptly recurved hooks; second, the row of broad hooks is flanked on either side by a series of long, slender, arcuate hooks arranged side by side in groups of four. Between the two latter series, on the side of the proboscis there is a longitudinal space from which hooks are apparently absent. All the hooks are prominent and stand out at nearly right angles to the axis of the proboscis. The following measurements show some of the differences between this species and *R. hispidum*: Diameter of proboscis exclusive of hooks 0.02^{mm}, including hooks 0.05^{mm}; length of broad hooks at base of proboscis 0.019^{mm}, breadth 0.019^{mm}; length of broad hooks middle of proboscis 0.008^{mm}, breadth 0.009^{mm}; length of slender hooks 0.02^{mm}, breadth 0.006; distance between transverse spirals 0.02^{mm}.

Following are the dimensions of the two alcoholic specimens:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	2.30	1.26
Length of head	0.16	0.20
Breadth of head	0.36	0.42
Length of head and neck	0.86	1.00
Breadth of neck	0.16	0.22
Length of contractile bulbs	0.46	0.48
Length of first segment	0.04	0.06
Breadth of first segment	0.14	0.14
Length of last segment	1.04	0.20
Number of segments	5	3

The first two segments are rather indistinct and indicated by two transverse lines. The last segment in No. 1 is linear, rectangular, and about the same breadth as the first segment. There is an ovary at the posterior end and a series of comparatively large, subelliptical bodies, presumably the testes filling up the interior. There is also a faint indication of the beginning of a cirrus bulb just back of the posterior third and near the margin.

I would prefer to regard this species as a variety of *R. hispidum* if it were not for the difference in the character of the hooks.

31. *Rhynchobothrium tenuispine*, sp. nov.

[Plate XII, Figs. 1, 2.]

Head and neck much as in *R. hispidum*, but red spots in neck indistinct or absent altogether. Proboscides long and slender, densely beset with exceedingly minute spinose hooks, slightly swollen near the base. A few of the hooks behind the tumid part are strongly recurved and a little stouter than the others. On the tumid part and as far forward as could be seen the hooks are slender, spinose, and slightly recurved. On one side of the tumid base there are a few slender hooks with abruptly recurved points. First two segments usually moniliform; remainder of strobile much as in *R. hispidum*.

Habitat.—Trygon centrura, spiral valve, August 1 and 3, 1887, Wood's Holl, Massachusetts.

In the following measurements from alcoholic specimens the diameter of the head is the maximum, obtained by measuring the head in lateral view, in which the bothria appear as widely flaring at the posterior edges. Only the measurements of head, neck, and first segments are given. In all the alcoholic specimens the posterior segments have dropped off.

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Length of head and neck	1.10	1.00	1.00	1.30
Breadth of head	0.20	0.22	......	0.32
Breadth of neck	0.14	0.10	0.10	0.14
Breadth of neck at contractile bulbs	0.20	0.16	0.16	0.26
Length of contractile bulbs	0.50	0.40	0.40	0.60
Length of first segment	0.10	0.12	0.12	0.12
Breadth of first segment	0.10	0.08	0.12	0.20

In all the above, except No. 4, the first two segments were rounded at the extremities so as to appear distinctly beaded.

A few mature segments associated with this lot measured as much as 1.6^{mm} in length and 0.3^{mm} in breadth. They are elongated, oppressed at the ends, tapering gently towards the posterior end, with somewhat irregular sinuous outline.

The proboscides are evidently very long, since, although none were seen fully everted, they could in some instances be traced back, not only through the entire length of the sheaths, but into the contractile bulbs themselves.

The following measurements of proboscides and hooks are from alcoholic specimens:

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Diameter of tumid base of proboscis	0.027	0.022	0.025	0.019
Length of hooks in front of tumid base	0.003	......	0.003	0.005
Maximum length of hooks near base	0.006	......	0.006	0.007
Breadth of largest hooks	......	......	0.001	0.001
Diameter of proboscis in front of tumid base	0.020	0.016	0.017	0.014

In all cases, with one exception, these specimens with the fine hooks on the proboscides had moniliform anterior segments, usually two in number. Conversely the coarser hooked proboscides of *R. hispidum* were associated with indistinct, squarish, anterior segments.

This species is evidently near *R. heteromerum* Diesing, with which it agrees closely, with the exception of that very important character, the length of the proboscides. According to Diesing's description, the proboscides are scarcely longer than the bothria. Diesing's species is made to accommodate Wagener's *Tetrarhynchus trygonis brucconis.* Wagener's figure of this species represents a worm with short proboscides, or, what is more likely, with long proboscides partly everted. In the absence of a better description of the hooks on the proboscides than is given for *R. heteromerum*, it is not possible to refer any of these small *Rhynchobothria* from *Trygon centrura* to that species.

32. *Rhynchobothrium heterospine*, sp. nov.

[Plate XII, Figs. 3–6.]

On August 4, 1886, I obtained a single immature *Rhynchobothrium* from the spiral valve of the smooth dog-fish (*Mustelus canis*), which, upon re-examining at leisure, I find is specifically different from the other *Rhynchobothria* in my collection. I either neglected to make notes of this specimen while it was living or, if notes were made, they have not since turned up. The specimen has been subjected to some pressure while in a fresh state, and its flattened condition makes it difficult to determine whether the bothria are marginal or lateral, and, of course, exaggerates the measurements of breadth.

Bothria two, opposite, lateral, short-elliptical or suborbicular. Neck long, cylindrical, compressed, slightly enlarged at base, in vicinity of contractile bulbs. Proboscides very long and slender, sheaths spiral, contractile bulbs linear-oblong. Hooks mostly slender, but of very diverse shapes.

Segments begin some distance back of contractile bulbs. Last segments elongate. Genital apertures marginal.

Habitat.—*Mustelus canis*, spiral valve, single immature specimen, August 4, 1886, Wood's Holl, Massachusetts.

The dimensions of the alcoholic specimen, much flattened, are as follows: Length, 13.50^{mm}; length of head, 0.60^{mm}; breadth, 0.70^{mm}; diameter of neck, 0.26^{mm}; length of head and neck, 3.00^{mm}; length of proboscides, approximate, 1.60^{mm}; length of contractile bulbs, 0.52^{mm}; breadth, 0.12^{mm}.

In this specimen, which is evidently immature, the segments are indistinct. The last segment measures 1.80^{mm} in length and 0.50^{mm} in breadth and tapers to a blunt point at the posterior end. Three or four elongated segments are marked off at the posterior end of the strobile by faint transverse lines. These are filled by the characteristic nuclear masses which precede the genitalia in the *Cestoda*, and from which the organs of the segment are differentiated. The genital organs are not yet distinct but are sufficiently developed to show that the male genital aperture is marginal.

The diameter of the proboscides, exclusive of hooks, is about 0.03^{mm}; with hooks included it is about 0.05^{mm}. The maximum length of hooks is 0.027^{mm}, their breadth 0.005^{mm}. In general the hooks are of at least four kinds, which, graduating as they do into each other, produce some very diverse forms. First, there are nearly straight hooks tapering to a sharp point; second, slender, arcuate, sharp-pointed hooks; third, slender, straightish hooks with abruptly recurved point, some transition forms with gentle sigmoid curve like the leter S partly straightened out; fourth, like the third form, into which it graduates, except that the shaft of the hook is quite broad in a plane coinciding with the longitudinal axis of the proboscis, the recurved end separated from the shaft by a

narrow notch. Since these varieties graduate into each other, it can be readily understood that there must be much diversity in the shape of the hooks of this species. Some of the straight, slender hooks, when seen as they lie on the side of the proboscis which is directly in view, are quite broad toward the base, being flattened in a plane which is at right angles to the longitudinal axis of the proboscis. These hooks when seen in this position with their broad basal supports look like broad, thin tacks. Eight or nine hooks can be seen at once in a single transverse spiral. The longest hooks that were measured were near the base of the proboscis. The hooks vary in length from 0.013 to 0.027^{mm}. The average length is perhaps not far from 0.016^{mm}.

33. *Rhynchobothrium imparispine*, sp. nov.

[Plate XII, Figs. 7–9.]

Bothria two, lateral, oblong-elliptical, distinctly emarginate posteriorly, deeply hollowed out on the face, margins slightly inverted, very versatile, head quite broad, bluntly sagittate, the bothria flaring outward at their posterior edges, approaching each other but not touching anteriorly. Neck three or four times as long as the head, cylindrical in front, flattened posteriorly. Proboscides long, moderately slender, armed with hooks which present great differences both in shape and size; sheaths spiral; contractile bulbs long, slender, tapering slightly posteriorly. First segments begin a short distance behind the neck, exceedingly short, subsequently increasing in length uniformly, becoming at length elliptical-oblong and longitudinally striated. Ultimate and free segments much longer than broad, with about fourteen longitudinal muscular striæ on a lateral side.

Genital apertures; male, marginal near posterior end, from deep rectangular marginal notch. Length 50^{mm}.

Habitat.—Raia erinacea, spiral valve, one specimen, Wood's Holl, Massachusetts, August 29, 1887.

On August 29, 1887, I examined twenty-four specimens of the Summer-skate (*Raia erinacea*). Their stomachs were filled with small crustacea, mostly shrimps (*Crangon vulgaris*), and annelids of the genera *Nereis* and *Rhynchobolus*. The entozoa from this lot of skates were several specimens of *Echeneibothrium variabile* from the spiral valve of some, a number of Nematods from the stomach and spiral valve of some, and a single *Rhynchobothrium*, the subject of this sketch.

The living specimen was very active when placed in sea-water and changed its form so incessantly that it was impossible to obtain satisfactory measurements. The bothria were plainly two, although appearing bilobed, on account of the deep posterior emargination. They were very versatile and were frequently directed forward, assuming then a cupular shape. The last segments were plump, the whole worm being in fact rather thick. The length was 50^{mm}; breadth of head, 1^{mm};

breadth of neck, 0.6^{mm}; length of neck, 4.5^{mm}; length of last segment, 2.5^{mm}; breadth, 1.65^{mm}. A free segment, which I think belonged to this specimen, measured 5^{mm} in length. When placed in sea-water it discharged a mass of eggs which spread out on the bottom of the dish making a spot 5^{mm} in diameter which was at first an opaque white color changing after a few hours to dark brown.

The following data were obtained from the alcoholic specimen: The bothria are 1^{mm} in length and 0.76^{mm} in breadth. In lateral view, marginal as to the body, the head is 1.26^{mm} broad in posterior diameter, 0.6^{mm} in anterior diameter. The neck in front of the contractile bulbs is cylindrical and about 0.6^{mm} in diameter immediately behind the bothria, increasing to 0.8^{mm} immediately in front of bulbs. In the vicinity of the bulbs the neck flattens to coincide with the flattened body. At the base of the contractile bulbs the marginal diameter is 0.47^{mm}, lateral 0.66^{mm}. Length of contractile bulbs 1.66^{mm}, breadth 0.28^{mm}. Approximate length of proboscides 2^{mm}; diameter, exclusive of hooks, 0.1^{mm}, diameter including hooks from 0.14 to 0.16^{mm}. In general there are two sorts of hooks classified according to size. The largest hooks have linear dimensions which are ten or even twenty times those of the smallest hooks. There are, however, a few that are intermediate between the larger and smaller hooks. Of the larger hooks there are three principal types. In the first type the hooks have broad bases abruptly and strongly recurved, the recurved part parallel with the axis of the proboscis or even turned a little toward the proboscis and equal in length to half the entire length. These hooks are the largest and strongest of all. At the base of the proboscis they measure 0.06^{mm} from tip to opposite extremity of basal support, length of base 0.04^{mm}, breadth of hook near middle 0.02^{mm}. Toward the end of the proboscis these hooks grow smaller, the corresponding dimensions of a similar hook there being 0.03^{mm}, 0.02^{mm}, 0.01^{mm}. There appears to be a single longitudinal row of these stout hooks, with two additional rows of hooks of nearly similar shape but smaller in size. The second type of large hooks is long, more slender than the foregoing, and strongly but not so abruptly recurved, with rather blunt points. One row stands near the row of stout hooks. At the base of the proboscis they measure, with the curve, as much as 0.06^{mm} in length and are about 0.01^{mm} broad at base. Towards the apex of the proboscis they become shorter and more slender. The tip of the recurved part was in some cases observed to bend toward the proboscis to form a veritable hook. The third style of large hook is slender, arcuate, rather sharp pointed, 0.04^{mm} in length and 0.013^{mm} broad at base, tapering uniformly to the tip. There are also some similarly shaped hooks about one-half as long and about one-third as broad. Closely allied to this style are some slender hooks which are curved in two planes, like the horns of an ox. Next below these come the largest of the small hooks, not more than 0.014^{mm} in length. The smallest hooks are only about 0.002^{mm} in length. On one side of the proboscis these

small hooks are arranged in double transverse rows between the transverse rows of large hooks. In this case the hooks in the anterior row are much longer than those in the posterior row, while in both the hooks are slender. On the side of the proboscis opposite the row of broad, stout hooks there is, at least at the base of the proboscis, a longitudinal space in which there are no large hooks. This space is densely covered with small hooks, which are very short, with broad bases. There appear to be about nine longitudinal rows of large hooks, the hooks in each row differing more or less from those in every other. The figures (Figs. 8 and 9, Plate XII),—while not showing all the varieties of hooks, nor their arrangement in toto, give a very correct idea of the kind of hooks and their arrangement.

Transverse striæ, indicating the beginning of segments, begin about 0.4^{mm} back of the contractile bulbs. The first distinct segments are 0.6^{mm} wide and 0.06^{mm} long. One of the posterior segments had the following dimensions: Length, 2.4^{mm}; breadth, anterior 1.2^{mm}, at marginal aperture 1.48^{mm}, posterior 1^{mm}; thickness, 0.9^{mm}; marginal genital aperture about 0.7^{mm} from the posterior end. When the cirrus is retracted it leaves a rectangular notch or emargination, with rounded, projecting lips. The cirrus was partly everted in one segment; it scarcely extended beyond the marginal notch, which it filled completely. It measured 0.12^{mm} in length and 0.1^{mm} in diameter, was smooth, tumid at outer end and at base, with constriction in the middle.

When placed in glycerine the posterior segments are seen to be marked with a number—fourteen, more or less—of longitudinal striæ, which converge at the two extremities near the median line, whence they radiate like meridian lines from the poles of a globe.

Anatomy of posterior segments.—An examination of a few thin sections of posterior segments yields the following rather meager data: The ovaries lie near the base of the segment and consist of two paired, roundish organs, lying on either side of the median line, each about 0.2^{mm} in diameter, and made up of small, polygonal, nucleated cells 0.005^{mm} in diameter. A convoluted mass of one or more tubes lies immediately in front of the ovaries, occupying the median line from the anterior edge of the ovaries to a point a little in front of the cirrus bulb, thence it bends back and communicates with the cirrus bulb. It is evidently, in part at least, the vas deferens. In front of this convoluted mass there is a thick-walled tube of very different appearance, which extends along the median line and appears to approach the exterior at the anterior edge of the segment. This is probably the uterus, and its extremity at the anterior edge of the segment an external orifice whence ova are expelled from ripe proglottides. I can find no trace of a vagina, unless the thick-walled tube which I suppose to be the uterus should prove to represent that organ. A very characteristic feature of these segments is the strong bands of longitudinal striæ which lie in the lateral walls. Ova were observed in some of the sections. They lay in the postero-

median part of the segment and were much collapsed. They measured about 0.05^{mm} and 0.025^{mm} in their two diameters.

On September 6, 1887, I obtained a large, free proglottis from this same species of skate (*Raia erinacea*) which belongs undoubtedly to this *Rhynchobothrium*, although no *Rhynchobothrium* scolex was found. The proglottis was 1^{mm} broad and 3.5^{mm} long. Ova were observed making their escape from the compressed segment in glycerine at the genital aperture near one of the margins. They are collapsed and measure 0.055 and 0.027^{mm} in their two diameters. Longitudinal striæ appear which converge at the two ends to a small circular hilum, which marks the former point of attachment to adjoining segments.

This species is evidently near Van Beneden's *Tetrarhynchus erinaceus* from *Raia rubus*, which it closely resembles in the character of its hooks. It also possesses many characters common to *Rhynchobothrium commutatum* Dies., and *R. ambiguum* Dies.

34. *Rhynchobothrium wageneri*, sp. nov.

[Plate XII, Figs. 10–12.]

Bothria two, lateral, orbicular, or, in alcoholic specimens, broadly elliptical, emarginate on posterior edge, somewhat bilocular, converging in front, widely divergent behind, with smooth, thickened, and elevated edges. Proboscides four, in two pairs, a pair issuing from anterior part of each bothrium. Inner side of base of each proboscis with a prominent shoulder, and with a single large, recurved hook on outer side opposite the shoulder; base of proboscis covered with small, slender hooks, remainder of proboscis armed with larger hooks. Proboscides three or four times as long as bothria, tapering gradually to apex. Neck long, cylindrical, broader than the body, very contractile in front of bulbs; proboscis sheaths in loose spirals; contractile bulbs very long, parallel. Body crossed by a narrow, transverse, crimson band immediately behind the contractile bulbs. The segments begin almost immediately behind the contractile bulbs. The first three or four distinct segments are broader than long. The next are squarish. At about the tenth they begin to elongate and mature. They increase rapidly in length towards the posterior end, the median ones becoming bacilliform while the last one is, in some cases, eight or ten times as long as broad. The last two or three are usually very long, fusiform, of an ivory-white color, and discharge ova when placed in water. The body throughout is almost cylindrical. Genital apertures marginal near middle of segment. Ova spheroidal, 0.029^{mm} in diameter. Length, 18^{mm}.

Habitat.—Trygon centrura, spiral valve, about ninety specimens from two rays, Wood's Holl, Massachusetts, August 10, 1887.

Of the following measurements, those of No. 1 are of a living specimen, Nos. 2 and 3 are of alcoholic specimens.

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	18.00	13.00	14.00
Breadth of head	0.80	0.54	0.52
Length of head	0.46	0.28	0.24
Length of head and neck	3.00	2.20	2.40
Diameter of neck	0.64	0.32	0.30
Length of contractile bulbs	2.00	1.20	1.26
Breadth of contractile bulbs	0.20	0.10	0.10
Length of first segment, approximate	0.03	0.03	0.03
Breadth of first segment	0.30	0.24	0.22
Length of last segment	4.00	2.40	2.80
Breadth of last segment	0.46	0.50	0.44
Length of proboscis	1.60	1.40	1.20
Diameter of proboscis at base	0.08	0.08	0.08
Diameter of proboscis near apex	0.04	0.05	0.05
Number of segments	20	16	16

In the alcoholic specimens the length of bothrium was 0.28^{mm}, breadth 0.30^{mm}. The anterior segments were indistinct.

The base of each proboscis for a distance of about 0.12^{mm} is 0.08^{mm} in diameter. At this point there is a sudden offset where the diameter suddenly diminishes to 0.06^{mm}, thus giving rise to a prominent shoulder which is always on the inner side of the proboscis. The basal part of the proboscis is thickly covered with slender, slightly recurved hooks, which are from 0.005 to 0.010^{mm} in length and less than 0.002^{mm} in thickness. These hooks are arranged in spirals, the coils of which make rows of hooks almost transverse to the axis of the proboscis. The hooks are longer and straighter near the head than they are at the offset. On the outer side of the proboscis, opposite to and a little way back of the basal shoulder, there is a single large hook. This hook is broad, recurved and has a strong basal support. Its length is 0.04^{mm}, breadth at surface of proboscis 0.017^{mm}, breadth of basal support 0.021^{mm}. Beyond the basal shoulder the proboscis tapers very gradually to the apex, which in well everted proboscides is about 0.04^{mm} in diameter, or one-half the diameter at base. The proboscis in front of the basal shoulder is covered with slender hooks, which are for the most part but slightly recurved. The maximum length of these hooks is about 0.015^{mm}, breadth at base 0.002^{mm}. They are arranged in spirals 0.016^{mm} apart, eight or nine hooks being visible in a single spiral. The coils of the spiral are more rapidly ascending than they are at the base. Towards the apex the hooks grow somewhat smaller. There is a slight difference between the hooks of opposite sides of the proboscis immediately above the basal part. On the outer side—that is, the side which bears the large basal hook—they are small, short, rather stout, sharply recurved, and about

0.005^{mm} in length, or one-eighth the length of the large hook. On the opposite side they are slender, slightly recurved, and about 0.015^{mm} in length.

The narrow crimson band at the base of the contractile bulbs is 0.02^{mm} wide, and occupies the entire breadth of the body. The elongated rod-like segments which immediately precede the mature segments contain a double row of large, elliptical bodies, lying one on each side of the median line. The cirrus is smooth, slender, of moderate length, and opens about the middle of the margin of the segment. The interior of the mature segments is filled with the very numerous ova.

This *Rhynchobothrium* is evidently the adult form of a species either identical with the larval *Rhynchobothrium* from *Cepola rubescens* figured by Wagener (Nov. Act., Nat. Cur., XXIV, Suppl. 48 and 82, Plate XIX, 230–234), or at least closely related to it.

The figure of the proboscis given by Wagener shows the same remarkable peculiarities which characterize this species. The shape of the bothria, the proportions of the head, neck, proboscides, contractile bulbs, as shown in Wagener's figures, agree with these specimens from *Trygon centrura.* Wagener does not give a specific name to the larval form. He simply designates it as "A *Tetrarhynchus* from *Cepola rubescens.*"

So far as I am aware, the adult has not been found. I therefore propose, as a proper specific designation for this species, the name *R. wageneri*, in honor of the original describer of what is probably the larval form of the species.

35. *Rhynchobothrium lomentaceum* Dies.

[Plate XIII, Fig. 1–3.]

Diesing, Syst. Helm., I, 571; Révis. des Cepth. Par., 290. Von Linstow, Comp. Helm., 280.

I refer a single *Rhynchobothrium* from *Mustelus canis* to Diesing's *R. lomentaceum* from *M. vulgaris.* This is done with some hesitation, for, although it does not disagree with Diesing's description, the latter is confined to such general characters that specific differences might still exist between my specimen and *R. lomentaceum.* It should also be remarked that the armature of the proboscides resembles very closely that of *R. caryophyllum* Dies. from *Scoliodon lalandii.* (Denks. der kais. Akad., XII, 30, Plate IV, figs. 16–20.)

Diesing gives the following description of *R. lomentaceum:*

Head with oval, lateral bothria converging at the apex. Neck slightly depressed. Body lanceolate, first segments very short, transversely oblong, each with rounded margin and swollen in the middle. Genital apertures. . . . Length of head and neck, 4^{mm}; length of body, 36^{mm}; breadth of posterior, 4^{mm}.

My specimen consists of the head, neck, and a few of the first segments, the whole measuring, when living, 9^{mm}. There is also a fragment containing a number of median segments and measuring, when

living, 10.5^{mm}. The last segment of this fragment was 1.1^{mm} long and 1.7^{mm} broad. The length of the head and neck in the living specimen was 3.5^{mm}; length of contractile bulbs 1^{mm}.

Following are dimensions of the alcoholic specimen: Length of head 1.44^{mm}, breadth 1.66^{mm}; length of bothria 1.60^{mm}, breadth 0.92^{mm}; length of head and neck, 3.14^{mm}; diameter of neck, marginal, 1.10^{mm}, lateral 1^{mm}; length of contractile bulbs 1.08^{mm}, breadth 0.26; distance from base of bulbs to first distinct segment, 3^{mm}; length of first distinct segment 0.16^{mm}, breadth 1.20^{mm}; greatest breadth of segments 1.80^{mm}, length 0.80^{mm}; lateral diameter behind bulbs, 0.90^{mm}; marginal diameter, 0.56^{mm}; diameter of proboscides, 0.12^{mm}.

The following description is based on the single alcoholic specimen: Head broadly sagittate. Bothria two, oval, narrow in front, broad behind, with thick, entire edges, a very faint emargination on posterior edge, converging at apex of head, flaring posteriorly, so as to give to the head the shape of an equilateral triangle. Neck a little longer than head, swollen in front of contractile bulbs, fusiform on account of contraction in length, slightly constricted at base of contractile bulbs. Proboscis sheaths spiral, contractile bulbs four times as long as broad. Proboscides longer than bothria; hooks of two principal sizes, the larger ones stout, broad, and strongly recurved, the smaller ones also broad and strongly recurved, but some of them proportionally more slender than the larger ones, a few slender and arcuate. Larger hooks on outer side of proboscides, smaller ones on inner side. First segments very short and broad; succeeding segments also short and broad, with rounded margins; margins of segmented part of strobile crenulate.

Male genital aperture marginal, about middle of segment.

Habitat.—Mustelus canis, spiral valve, one specimen. Wood's Holl, Massachusetts, August 11, 1887.

The only details that the small amount of material at hand permits relate to the disposition of the hooks on the proboscides. The largest hooks are 0.04^{mm} in their greatest length, and 0.02^{mm} broad at base. The smaller hooks are from 0.01 to 0.02^{mm} in length, and from 0.004^{mm} to 0.01^{mm} in breadth. The spiral series of hooks are 0.035^{mm} apart, and the hooks in each series are situated from 0.01^{mm} for the larger to 0.02^{mm} for the smaller from each other. The arrangement seems to be as follows: On the outer side of the proboscis there are four longitudinal rows of large, strongly recurved hooks. On the opposite or outer side there are four longitudinal rows of hooks, much like the large hooks in shape and proportion, but having only about half their lineal dimensions. The series of large hooks is flanked on each side by two rows of hooks which are somewhat smaller and proportionally a little more slender than the large hooks. Between each of these two series of intermediate hooks and the inner series of small hooks there is a single row of hooks consisting of alternately large and small hooks.

The larger of these two styles of hooks are, however, small-sized, and correspond, both in shape and size, to the hooks in the inner series. The smaller alternates of this row are but slightly recurved. The larger alternates are about 0.017^{mm} long and 0.008^{mm} broad at base; the smaller ones are 0.011^{mm} long and 0.005^{mm} broad at base. To recapitulate, there are four rows of large hooks on outer side of proboscis, four rows of small hooks on inner side, two rows of intermediate hooks on each side of the series of large hooks, one row of alternately larger and smaller hooks on each side of the series of small hooks, thus making fourteen rows in all. All the hooks are smaller and more slender near the base of the proboscis.

The fragment of strobile which was found associated with the scolex, and which evidently belongs to it, does not contain any mature segments. The posterior segments are somewhat elongated and are narrower than the preceding segments. None of the genital organs could be made out except the cirrus, which could be seen through the walls of the segment when the latter were rendered transparent with glycerine. The male genital aperture is marginal about the middle. The walls of the segments are traversed by many strong, longitudinal, muscular fibers.

36. *Rhynchobothrium longicorne*, sp. nov.

[Plate XIII, Figs. 4–8].

Head appressed, truncate, and emarginate in front. Bothria two, lateral, oblong-elliptical, parallel in front, slightly divergent behind, slightly emarginate on posterior edge, somewhat bilobed by a low, short, longitudinal, median ridge near the posterior end of the shallow face. Neck long, but capable of great contraction, subcylindrical. Proboscides very long, three or four times as long as the bothria, tapering to apex, with tumid basal portion covered with fine, slender, straightish appressed hooklets; remainder of proboscis armed with longer, slender, curved hooklets of nearly uniform size. Proboscis-sheaths very long, in contracted specimens lying in broad, crowded, sinuous folds. Contractile bulbs elliptical or elliptical-oblong. Segments begin very soon behind contractile bulbs; at first very short, subsequently increasing in length, then becoming as long as broad; last segments rectangular, longer than broad. Body relatively short, compressed, at first a little wider than neck and increasing in breadth but little throughout its length.

Genital apertures male marginal, near anterior edge, its position in some specimens marked by an evident notch; female lateral at middle point of median line (?). Eggs oval about 0.04^{mm} in longer diameter.

Habitat.—Odontaspis littoralis, spiral valve. Wood's Holl, Massachusetts, July, 1885; August, 1886.

I have found this species on two different occasions, each time in the sand shark (*Odontaspis littoralis*). The first specimens, three in number, were collected July 15, 1885; the second, four in number, August 12, 1887.

In the following, No. 1 was a living specimen somewhat flattened under the compressor; Nos. 2 and 3 alcoholic. Nos. 1 and 3 are doubtless the same individual.

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	14.00	8.50	10.00
Length of bothria	2.00	0.92	1.23
Breadth of bothria	......	0.66	0.80
Length of head and neck	5.20	2.80	3.10
Diameter of neck	......	0.46	0.52
Length of contractile bulbs	1.06	0.80	1.04
Diameter of contractile bulbs	0.34	0.16	0.18
Length of proboscis	6.40	......	......
Distance from base of bulbs to first segment	0.80	0.60	0.60
Length of first distinct segment	0.10	0.10	0.10
Breadth of first distinct segment	1.00	0.68	0.60
Length of last segment	2.20	1.20	1.56
Breadth of last segment	1.40	0.86	1.04
Number of segments	24	16	24

In No. 1 the last 17 segments show the reproductive organs.

From a specimen collected July, 1885, the following measurements were obtained: length of head, 3^{mm}, breadth, 2^{mm}; length of neck, 6^{mm}; breadth, 1.3^{mm}; length of contractile bulbs, 1^{mm}, breadth, $0{\cdot}5^{mm}$; length of posterior segment, 4^{mm}, breadth, 2.5^{mm}.

Some dimensions of proboscides and hooks are: diameter at base, excluding hooks, 0.097^{mm}; including hooks, 0.1^{mm}; median diameter, excluding hooks, 0.066^{mm}; including hooks, 0.102^{mm}; length of hooks on base of proboscis, 0.02 to 0.03^{mm}; breadth, 0.004^{mm}; length of median hooks, 0.04^{mm}, breadth, 0.007^{mm}.

The tumid base of each proboscis is prominently shouldered on the outer side. In this respect it resembles *R. wageneri*. There is, however, no single large hook as in that species, and besides there is a very great difference between *R. wageneri* and *R. longicorne* in respect to the conformation and arrangement of the hooks.

Behind the basal enlargement the hooks are nearly straight, appressed closely to the surface of the proboscis, slender, sharp-pointed, and, many of them, with a single short lateral basal prolongation. The spirals are about 0.01^{mm} apart, while the longest hooks are over 0.03^{mm} in length. The points of the hooks in one spiral therefore cover the bases of the preceding series. The hooks on the outer side of this part of the proboscis are larger than those on the inner side. On the anterior part of the basal enlargement of the proboscis they are smaller and crowded together closely. The spirals are here about 0.005^{mm} apart, and twenty-five hooklets and over may be counted in a single transverse spiral. There is some variety in the shape of the hooks on the basal enlargement. On its outer part they are, in the main, straight and slender. Toward the inner side on the anterior slope there are about five spiral series in which the hooklets are placed close together side by side. These hooklets stand

nearly erect, are moderately broad and abruptly recurved at the point. In front of the basal enlargement the hooks are, in the main, slender, sharp-pointed, and arcuate, from 0.022^{mm} to 0.033^{mm} in length, the spirals about 0.02^{mm} apart, about eight hooklets visible in each spiral. The hooks, for the most part, are nearly erect. There are, however, on one side of the proboscis, two longitudinal rows of hooks, which are stouter than the hooks in the other longitudinal rows, and are strongly appressed, the hooks in each row pointing toward the other row. This arrangement seems to be very similar to that figured by Van Beneden for his *Tetrarhynchus minutus* from *Squatina angelus.* These two rows of appressed hooks are flanked on the one side by a row of rather short broad-based hooks, strongly recurved, and on the other by a row of rather short arcuate hooks. The remaining hooklets do not differ from each other either in size or shape. They are long, slender-pointed, arcuate, nearly erect, and impart a characteristic bristly appearance to the proboscis. The proboscides taper gently toward the apex, where there is much less diversity both in size and shape of hooks than there is farther back.

The lateral vessels of the water vascular system remain plainly visible in an alcoholic specimen lightly stained with hæmatoxylon. The body is short, broad, and much flattened. In the mature segments the ova are collected in a mass at the bottom of an elongated clear space, which begins at the marginal genital aperture near the anterior end, runs directly to the median line, follows the latter to near the posterior end, where it expands into the cavity in which the ova are lodged. The cirrus was not observed. I have not been able to demonstrate the position of the female genital aperture in the alcoholic specimens, but am disposed to think that it is lateral, from the fact that, in a living specimen, there were distinct median lateral apertures on the squarish segments in front of the mature segments.

OTOBOTHRIUM, gen. nov.

[οὖς, ὠτός, the ear.]

Body articulate, tæniæform, head separated from body by a neck. Bothria two, opposite, lateral, each with two supplemental ciliated pits at the posterior free angles. Proboscides four, terminal, filiform, armed, retractile in neck. Reproductive apertures marginal.

According to Diesing's classification this genus belongs to the subtribe *Trypanorhyncha* and the family *Dibothriorhynchidæ.* The number of the bothria allies it with the genus *Rhynchobothrium.* On the other hand the neck of *Otobothrium* bears a close resemblance to that of *Tetrarhynchus.* The reason for separating it from *Rhynchobothrium* and erecting it into a new genus is found in the presence of the four otosacs or ciliated pits. These, if not homologous with the supplemental disks of *Calliobothrium*, etc., certainly furnish a character of as much weight in classification as they.

37. *Otobothrium crenacolle*, sp. nov.

[Plate XIII, Figs. 9–15, and Plate XIV, Figs. 1–4.]

Head broad, transverse, hammer-shaped, or, in alcoholic specimens, bluntly rounded in front and cordate, compressed. Bothria two, opposite, lateral, sub-rectangular or oblong-elliptical, bilocular, slightly emarginate on posterior edge, converging in front, widely divergent behind; each bothrium with two eversible, ciliated pits at the posterior edge. Faces of bothria hollowed out, edges somewhat thickened. Neck short, cylindrical, slightly compressed, broader, and much thicker than anterior part of the body, from which it is quite distinct, posteriorly projecting into a kind of collar with four deep notches opposite the sides and margins of the body. Proboscides slender, about twice the length of a bothrium, armed, for the most part, with strongly recurved hooklets, which are sharp-pointed with broad bases of uniform size and symmetrically disposed; about five visible at once in each of the diagonal rows. There are beside these some minute slender hooklets near the base of the proboscides. The proboscis-sheaths are spiral. The contractile bulbs are short, oval, and lodged at the base of the neck in the projecting lobes made by the posterior notches of the neck. The body is slender, compressed, and much narrower at first than the neck. First four segments very short, three or four times as broad as long. The remaining segments increase in length, rapidly becoming very long and slender, the posterior segment often from twelve to fifteen times as long as broad. Free proglottides slender, somewhat irregular in outline, very active. Ova subglobular, abundant. Genital apertures, at least male, marginal a little behind middle point.

Habitat.—Sphyrna zygæna, spiral valve, July 28, 1886, one hundred and fifty specimens; July 18, 1887, one hundred specimens; chyle swarming with free proglottides on both occasions. Wood's Holl, Massachusetts.

Numbers 1 and 2 of the following are from living specimens; 3 and 4, alcoholic.

Dimensions.	No. 1.	No. 2.	No. 3.	No. 4.
	mm.	*mm.*	*mm.*	*mm.*
Length	11.20	10.80	11.50	14.00
Length of bothria	0.22	0.22	0.20	0.22
Breadth of head	0.32	0.32	0.30	......
Length of head and neck	0.36	0.40	0.36	0.36
Diameter of neck	0.12	0.12	0.14	0.14
Diameter of neck at contractile bulbs	0.16	0.16	0.18	0.18
Length of contractile bulbs	0.10	......	0.08	0.06
Breadth of contractile bulbs	0.05	......	0.05	0.04
Breadth of first segments	0.08	0.10	0.10	0.12
Length of last segment	1.90	2.40	3.00	3.30
Breadth of last segment	0.28	0.20	0.36	0.30
Number of segments	16	18	17	20

The following details are taken from a living specimen slightly distorted under the compressor: Length, 9.30^{mm}; length of head and neck, 0.36^{mm}; breadth of head, 0.32^{mm}; length of bothria, 0.17^{mm}; diameter of neck, 0.10^{mm}; diameter at contractile bulbs, 0.13^{mm}; length of each of first four segments, 0.02^{mm}; breadth, 0.07; length of fifth segment, 0.04^{mm}; sixth, 0.08^{mm}; seventh, 0.12^{mm}; eighth, 0.16^{mm}; ninth, 0.30^{mm}; tenth, 0.44^{mm}; eleventh, 0.60^{mm}; twelfth, 1.^{mm}; thirteenth, 1.25^{mm}; fourteenth, 1.8^{mm}; fifteenth, 3^{mm}. The last of these segments were 0.10, 0.14, and 0.2^{mm} broad, respectively.

The length of the proboscides, estimated from specimens that had been made transparent, so as to show the retracted proboscides, seems to be from 0.5 to 0.6^{mm}. The longest everted proboscis measured 0.4^{mm}; diameter, excluding hooks, 0.011 to 0.016^{mm}; including hooks, 0.019 to 0.025^{mm}; length of hooks, 0.007 to 0.008^{mm}; breadth 0.003^{mm}; length of minute hooks at base of proboscides, 0.003; breadth, 0.001^{mm}; length of free proglottis, living, 4.4^{mm}; breadth, 0.8^{mm}.

In alcoholic specimens the bothria are invariably opposite and divergent at the bases, so as to give to the head, when viewed laterally, marginally as to body, a cordate or even reniform outline. The outline of the head and neck together is like that of a hammer, in which the neck represents the short thick handle. The head is only about half as thick as it is wide, *e. g.* in an alcoholic specimen the breadth of head was 0.28^{mm}; thickness, 0.14^{mm}; in this specimen the length of a single bothrium was 0.2^{mm}; its breadth, 0.14^{mm}. In another specimen the head was 0.32^{mm} broad and 0.14^{mm} thick.

In the living worm the faces of the bothria are frequently directed forward, and when viewed in this position their anterior edges are seen to be separated by a moderately wide space. A pair of proboscides emerges from the anterior edge of each bothrium. There is a slight emargination on the anterior edge of each bothrium, and another shallow emargination on the posterior edge. A median line extending from the shallow posterior notch to the front edge divides the bothrium into two loculi. This latter feature is often lost, or at least much obscured, in alcoholic specimens, in which the faces of the bothria are deeply concave, the lips sometimes much inflexed.

Supplemental pits or otosacs.—These organs appear under low magnifying power as four round spots, lying one at each of the posterior angles of the two bothria. When highly magnified, 250 to 300 diameters, these spots are seen to be oval or conical pits, lined with minute ciliary bristles, and about 0.025^{mm} in diameter. While examining one of these pits with a magnifying power of about 300 diameters, the specimen was subjected to a slightly increased pressure, when one of the pits was observed to evert itself, changing from an oval pit lined with ciliary bristles to a blunt conical papillary elevation, which was covered with erect bristles. In the alcoholic specimens some of these pits are everted into low papillæ. These remarkable pits are strongly suggestive of low

or rudimentary sense organs. A careful histological examination of the scolex may throw some light on their true nature.

Anatomy of mature segments.—The male genital aperture is marginal a little back of the middle. A lateral aperture was observed in a few free segments. It was situated near the anterior end of the segment, and is probably an opening for the discharge of ova, since careful search failed to reveal any corresponding opening on immature segments. The cirrus was not seen fully everted. The length in an alcoholic specimen was estimated to be about 0.6^{mm}, and the diameter at base 0.12^{mm}. It emerges from the center of a comparatively wide but shallow marginal notch. The vagina appears to open immediately behind the cirrus in the same marginal notch. The cirrus bulb is rather small, oval, and directed slightly forward. The vas deferens lies in a coil in front and at the base of the cirrus bulb, and enters the base of the bulb. The ovaries are small oblong, or oval, and lie one on each side of the median line and at about one-third the distance from the genital aperture to the posterior end of the segment. Back of the ovaries are a number of oval clear spaces.

The ova are nearly globular. A living ovum measured 0.024 and 0.022^{mm} in its two diameters. Ova in the preserved specimens, mounted in glycerine and slightly compressed, appear almost globular, and are 0.027^{mm} in diameter. They have smooth and rather thin shells, which must be quite rigid, as no eggs were observed with the shell collapsed or indented. In a few cases the ova are aggregated into a globular mass about the middle of the segment and a little in front of the genital aperture. This mass causes an abrupt swelling in the walls of the segment, which, upon slight pressure, bursts, releasing the eggs in vast numbers. Ova were also seen lying along the median line and in small clusters near the anterior end, whence they apparently find their natural outlet.

The anterior part of the mature segments which do not yet contain ova is filled with oval or elliptical bodies, which, according to analogy with other forms, doubtless represent the testes. In some these have disappeared along the median line, leaving a median sinus which evidently becomes a receptacle for ripe ova. There are usually only from 12 to 15 segments present in a single specimen. As the segments mature they separate easily.

On both occasions of finding this worm the chyle of the intestine was swarming with them and with the free proglottides. A few were found in the pyloric division of the stomach. The free proglottides, when placed in sea-water, continued very active for several hours. They were capable of active progressive motion by alternate contraction, and expansion of the body, during which each end often assumed the shape and performed the function of a sucker. The masses of ova in the living proglottides were, in some cases, ivory-white and opaque. In others they passed from white through yellowish to brown. Others were yellowish green.

I have had the opportunity of examining but two specimens of the hammer-head shark (*Sphyrna zygæna*). These were obtained in different years, and both yielded this parasite in abundance. The only other parasites found in this host were a single Nematod in the spiral valve of one, and a few cysts (Xenosites) in the muscular coats of the stomach of each.

Subfamily II.—Tetrabothriorhynchinæ.

Family *Tetrabothriorhynchidæ* Dies.

TETRARHYNCHUS Rudolphi.

Bothriocephali spec. Bartels.
Rhynchobothrii spec. Van Beneden and R. Leuckart.
Tetrarhynchi spec. Van Beneden.
Aspidorhynchus Molin.
Tetrarhynchobothrium Dies.

Body articulate, tæniæform. Neck tubular. Head with four bothria in two lateral pairs, parallel with the head. Proboscides four, terminal, filiform, armed, retractile in the neck, free, *i. e.*, not running through the bothria. Genital apertures marginal or lateral.

38. *Tetrarhynchus tenue*, sp. nov.

[Plate XIV. Figs. 5, 6.]

Head variable, but often sagittate. Bothria four, in two lateral pairs, long-oval, long-elliptical, or oblong. Proboscides four, somewhat quadrangular, a little shorter than the bothria, densely beset with very slender straightish or slightly arcuate spine-like hooklets, which are of nearly uniform size and shape. The proboscides emerge from a point a short distance back of the apex of the head. Neck tubular, contractile. In life it may be twice as long as the bothria, but in alcoholic specimens it is usually shorter than the bothria. Posteriorly it is continued in a collar which incloses the anterior part of the body. It is ordinarily broader than the anterior part of the body. The proboscis sheaths are nearly straight, with the exception of a single spiral kink in front of the contractile bulbs. The latter organs are short-oval—in alcoholic specimens less than one-third the length of the bothria. The segments begin immediately behind the neck as fine transverse wrinkles. The first distinct segments are very short, subsequently increasing in length, becoming squarish, then longer than broad. The posterior mature segments are considerably longer than broad, with a tendency, in alcoholic specimens, to become convex on the margins, thus giving a decidedly repand outline to the margins of the mature portions of the strobile.

Genital apertures: male, marginal, a little in front of the middle point. Cirrus rather short and smooth; female aperture lateral (?). Ova small, spheroidal, escaping from lateral aperture. General habit of body more slender, especially head and anterior part of body, than *T. robustum*.

Habitat.—*Trygon centrura*, stomach and pylorus. August, 1884 and 1887. Wood's Holl, Massachusetts.

Upon four different occasions I have obtained a few *Tetrarhynchi* from the stomach of the sting ray (*Trygon centrura*), which, with the somewhat hurried examination that was made of them while they were alive, were supposed to belong to the same species. After an examination of the alcoholic specimens, however, I find that there are two entirely distinct species in each of the four lots. These differ from each other most in the character of the hooklets on the proboscides, *T. tenue*, having minute spinose hooklets, while the hooklets of *T. robustum* are short, stout, and strongly recurved.

These parasites were found as follows:

Date of capture.	No. of rays examined.	No. of parasites found.
August, 1884	One	One.
August 1, 1887	Three	Two.
August 8, 1887	One	Three.
August 10, 1887	Two	One.

These specimens were all found either in the stomach proper or in the pylorus.

Of the following measurements No. 1 was a living specimen, the others alcoholic:

Dimensions.	No. 1.	No. 2.	No. 3.
	mm.	*mm.*	*mm.*
Length	19.00	20.00	13.50
Length of bothria	0.46	0.36	0.40
Breadth of head	0.30	0.24	0.26
Length of head and neck		0.56	0.48
Diameter of neck	0.24	0.18	0.20
Length of contractile bulbs	0.14	0.11	0.12
Breadth of contractile bulbs	0.05	0.05	0.04
Length of proboscides		0.28	0.20
Diameter of proboscides		0.02	0.026
Length of hooklets			0.0055
Breadth of hooklets			0.0014
Length of anterior segment, approximate	0.04	0.02	0.02
Breadth of anterior segments	0.18	0.12	0.16
Length of posterior segments	1.16	0.88	0.80
Breadth of posterior segments	0.70	0.58	0.24

In No. 1 the diameter of neck at collar was 0.18^{mm}; length of neck proper, 0.40^{mm}; length of collar, 0.14^{mm}; length of bothria, varying from 0.36 to 0.56^{mm}; posterior segments, from 0.94 to 1.16^{mm}.

In an alcoholic specimen, 13^{mm} in length, the length of the head and neck was 0.78^{mm}; in another, 17^{mm} in length, the length of the head and neck was 0.48^{mm}.

I take the following descriptive paragraph from notes made at the time of collecting: Bothria elongated in two lateral pairs, the bothria constituting a single pair united at the apex, each with an irregularly hollowed face and posterior bluntly rounded edges reflexed from the neck. Anterior part of head projecting about 0.1^{mm} in front of the bases of the proboscides, the latter shorter than the bothria. Neck short, tumid, constricted behind the short contractile bulbs and continued posteriorly into a collar which surrounds the anterior part of the body. The body is joined to the neck at the base of the bulbs. Fine transverse lines begin at once behind the collar. The first segments are broader than long. They increase in length rapidly and at a distance of 8^{mm} from the head are more then twice as long as broad. The posterior mature segments are somewhat irregular in outline and tumid in the middle. When placed in water the ripe segments are apt to burst at the middle of a lateral face, by means of a rapid papillary swelling from which the eggs escape. Under the compressor the dividing line between the ripe segments is indistinct.

The spheroidal ova measure about 0.019 and 0.014^{mm} in the two diameters. Some are nearly spherical and 0.019^{mm} in diameter.

The epidermis of one specimen exhibited a tendency to slough off after lying for a short time in sea-water. In some specimens, after having been placed in sea-water, it was observed that the mature segments had curved towards one of the lateral faces, burst about the middle, and discharged ova in such quantity as to leave a milky white patch at the bottom of the dish.

When alcoholic specimens were highly magnified the apex of the head and the edges of the bothria are seen to be densely covered with minute hair-like bristles, which are a little longer than the hooklets of the proboscis. These bristles belong to the epidermis, are easily rubbed off, can be seen only with a high magnifying power and hence may be easily overlooked.

In the mature segments the nearly spherical ova lie in scattered masses. These small aggregations are probably what remain of the ova, the greater part having escaped through the lateral aperture. The cirrus emerges near or a little in front of the middle point of the margin, thus differing from *T. robustum*, in which the cirrus opens near the anterior margin.

This species has many characters in common with *T. infulatum* (*Aspidorhynchus infulatus* Molin).

39. *Tetrarhynchus robustum*, sp. nov.

[Plate XIV, Figs. 7–9.]

Head bluntly rounded in front. Bothria four, oblong, hollowed out on the face, with flexible borders, distinctly arranged in lateral pairs, the bothria in each pair approximating at their fore posterior edges. Neck variable, usually cylindrical, broader than anterior part of body,

continued posteriorly into a collar which incloses the anterior part of the body, in alcoholic specimens often transversely wrinkled. Proboscides nearly equaling the bothria in length, armed with short, strongly recurved hooklets, sheaths nearly straight with a single spiral turn immediately in front of the contractile bulbs. The latter are long-oval, and a little more than one-half as long as the bothria. The body begins immediately behind the contractile bulbs, and is at once crossed by transverse lines which soon outline distinct segments. The first segments are very much broader than long. Subsequently they increase in length slowly, the posterior mature segments becoming at first squarish, then a little longer than broad. Male genital apertures marginal, irregularly alternate, near anterior edge. Cirrus small, smooth; cirrus bulb slender. Female genital aperture lateral(?).

Ova small, very abundant, nearly spherical, about 0.016^{mm} in diameter, and with a thin shell.

Habitat.—Trygon centrura, stomach and pylorus, August, 1884 and 1887, Wood's Holl, Massachusetts.

The general habit of *T. robustum* is stouter than *T. tenue.* The head, neck, and segments are relatively broader; the head is more blunt at the apex; the proboscides emerge from the apex of the head instead of a little way back of the apex; the hooklets on the proboscides are much stouter and more sharply recurved; the contractile bulbs are longer; the cirrus opens near the anterior end of the segment instead of near the middle.

I have found this species associated with *T. tenue*, as follows: August, 1884, two specimens; August 1, 1887, two specimens; August 8, fragments; August 10, one specimen.

The following measurements were obtained from alcoholic specimens:

Dimensions.	No. 1.	No. 2.
	mm.	*mm.*
Length	20.00	24.00
Length of bothria	0.68	0.60
Breadth of head	0.70	0.64
Length of head and neck	1.20	1.18
Diameter of neck	0.50	0.42
Length of proboscides	0.60	0.60
Diameter of proboscides	0.03	0.03
Length of hooklets	0.011	0.014
Breadth of hooklets	0.005	0.005
Length of contractile bulbs	0.33	0.32
Breadth of contractile bulbs	0.10	0.08
Length of anterior segments, approximate	0.02	0.02
Breadth of anterior segments	0.38	0.40
Length of posterior segments	0.52	0.86
Breadth of posterior segments	0.96	0.80

The hooklets are nearly uniform in shape, which is much like that of the claw of a cat. The breadth of base equals about half the length. At

the base of the proboscides the booklets have only about half the linear dimensions of those at the middle and near the apex. They are similar in shape except perhaps a little more recurved at the point. The hooklets are arranged in uniform spirals, which are about 0.017^{mm} apart. Seven hooklets can be seen in each spiral on one side of the proboscis.

The proboscides bear some resemblance to those of *T. bisulcatum* (*Rhynchobothrium bisulcatum* of my former paper), but are much smaller, being about half the diameter, and the hooks are about half as long. The hooks are also relatively more slender. The head and neck of *T. robustum* also resemble that of *T. bisulcatum*, but are not so plump. The edges of the bothria were covered with fine capillary bristles as in *T. tenue.* They were, however, not so abundant, nor were they observed at the apex of the head.

The segments in all but one of the specimens that I have yet seen were much broader than long. In one, the posterior segments to the number of ten or twelve, are squarish, and the last two or three a little longer than broad. The cirrus bulb in the mature segments extends from the marginal aperture, near the anterior edge, half the distance or more to the median line, and inclined forward toward the anterior edge. The vas deferens shows plainly, lying in voluminous coils at the base of the bulb and along the median line. The ovary is a broad two-lobed organ centrally placed. The ova lie along the median line. There yet remains much to settle with respect to the disposition of the genitalia of these segments which I have not yet studied from thin sections.

40. *Tetrarhynchus bisulcatum* Lt.

[Plate XIV, Figs. 10–12, and Plate XV, Fig. 1.]

Rhynchobothrium bisulcatum Lt. Report of U. S. Commission of Fish and Fisheries for 1886, pp. 479–486, Plate IV, Figs. 9–23.

In my original description of this species I regarded the bothria as two in number, but distinctly bilobed. Since writing the first description I have had an opportunity to study living specimens and have decided to refer the species to the genus *Tetrarhynchus.* I was perhaps misled by the close resemblance to Van Beneden's figures of *Tetrarhynchus lingualis* Cuv. (*Rhynchobothrium paleaceum* Rud. and Van Ben., Diesing, Revis. Ceph. Par., 294).

The only emendation necessary in the original description is to change from "bothria two, divided into two distinct lobes," to bothria four, arranged in two lateral pairs. Also the female genital aperture is marginal, beside cirrus.

On the 25th of July, 1887, I obtained from the pyloric division of the stomach of a dusky shark (*Carcharias obscurus*) a large lot of this species. There were about four hundred of these parasites crowded into a space of 8 or 10 inches in the narrow pyloric constriction of the stomach. A portion of this part of the alimentary canal cut open so as to

show the worms attached, is shown in Fig. 1, Plate XV. The bodies of the living worms were very much crumpled and folded and the heads and anterior segments were buried in the walls of the pylorus. On this account they were very difficult to remove. Usually the scolices were buried together in groups of from three to six or more in a common cavity. These cavities or pits extended through the mucous and sub-mucous coats into the muscular layers. The heads of many of the specimens were yellowish green, and nearly all were characterized by having a greenish band at the base of the neck or a greenish tubular neck.

In my former description I recognized three distinct varieties. In this lot the same varieties can be distinguished with, perhaps, a greater tendency to intermediate forms. A living specimen, with mature segments and measuring only 32^{mm} length, agrees in all essentials with var. α. Two others, which were quite long and slender, measuring 280 and 330^{mm}, respectively, answer, in the main, to the conditions established for var. β.

In general the specimens were not much changed by immersion in alcohol, hence the measurements already published for this species need not be added to in these notes.

An interesting abnormal form was found in this lot. It consisted of two slender but distinct strobiles with a single scolex. The strobiles measured 25 and 65^{mm}, respectively. This does not seem to be a mutilated specimen, since the two strobiles are distinct as they emerge from the cervical collar. The segments do not begin at once, and when they do they make their appearance at different distances from the head. The segments on the latter half of the longer chain agree in outline with those of var. β. The cirrus is quite distinct and emerges near the middle of a margin, or a little in front of the middle and runs thence diagonally to the anterior edge at the median line. There is no sign of lateral apertures. The posterior segment is 0.76^{mm} long and 0.66^{mm} broad.

In this species, in general, the cirrus emerges near the margin not far from the anterior edge of the segment. The only exception that I have noticed is in the case of some individuals of variety β, where the cirrus emerges not far from the middle of a margin. In all cases, however, the cirrus and its bulb extend from the marginal opening inward and forward until its base reaches almost to the anterior edge of the segment at the median line. The cirrus is slender, smooth, and tapering.

Anatomy of scolex.—I have not yet made a careful histological study of this species, but in endeavoring to settle some points in the anatomy of the mature segments I found it necessary to make thin sections of a few segments, and at the same time stained a scolex with carmine and cut it into transverse sections.

The muscular walls of the contractile bulbs are of surprising thickness. The bulbs lie close together, the limiting membrane of one fusing

with that of the other at the point of contact. The inner cavity, as shown in these sections, is very small, being, in fact, but little more than twice the diameter of the retractor muscle which it contains. The cavity instead of being central is really at one side. In each case it is at a side which adjoins one of the other bulbs, but so disposed that each of the four cavities lies at one of the partitions which separate the bulbs from each other. The thick wall of a bulb is composed of several, in some places as many as six or seven, alternating layers of muscular fibers, whose cut ends show that they run in alternating spiral directions from one end of the bulb to the other. The layers are rather thick, in some cases at least being equal to the diameters of a dozen fibers. The retractor muscle, which is itself made up of a number of parallel fibers, is usually oblong or elliptical in section, but sometimes nearly circular.

The following maximum dimensions show the proportions of these parts:

	mm.
Diameter of the bulb	0.158
Diameter of inner cavity of bulb	0.039
Diameter of retractor muscle	0.019
Thickness of muscular wall of bulb	0.111

Sections made near the anterior end of the head reveal a very dense tissue throughout. They are divided into quadrants by two bands of transverse fibers which bisect each other at the center. Toward the outer edge these transverse fibers become indistinct amidst the denser tissue of the outer part of the head. In each of the quadrants thus formed one of the proboscis sheaths lies. The walls of the sheaths are made up for the most part of fine circular fibers. In some of the sections the sheath, the proboscis, and the retractor muscle of the latter could be plainly seen. The walls of the proboscides are thicker than those of the sheaths, and like them are composed of circular fibers. The sheaths are accompanied on all sides, except that which is turned toward the central axis of the scolex, with strong longitudinal muscular fibers.

Near each sheath on the inner side, or rather between each sheath and the point at which the transverse bands of fibers cross, there is an irregular circular cluster of granules. They indicate the presence of longitudinal vessels, of whose exact nature I am not certain. They are stained deeply by the carmine, and are quite different in appearance from the cut ends of longitudinal muscle fibers. Towards the base of the sheaths these vessels have a distinct limiting membrane. Their cross-sections, in the mean time, become somewhat circular. They now lie close to the proboscis-sheaths. They follow the proboscis-sheaths to the anterior ends of the bulbs, where they disappear. I am inclined to regard them as nervous vessels.

In the sections behind the bulbs the tissues appear rather spongy, with longitudinal fibers interspersed. Towards the circumference there

is a predominance of circular fibers, which form an indistinct layer and in which a division presently takes place, the outer part and the granular tissue which is outside of it sloughing off to form the collar. Part of the circular layer then goes to form the outer cuticular layer of the body and another part goes to form the inner cuticular layer of the collar. In sections made through the anterior part of the body, still within the collar, the latter now appears as a concentric circle of dense granular tissue with a few circular fibers. The tissues of the body proper are, first, a thin cuticular layer; then a thick layer of spongy tissue with irregular open spaces and a few longitudinal fibers interspersed; next a layer of longitudinal fibers, into which most of the longitudinal fibers of the neck are now collected. This layer is about 0.027^{mm} thick, and surrounds a central core which is about 0.324^{mm} long, from margin to margin, and 0.035^{mm} broad.

Sections of longitudinal vessels lie at the marginal extremities of the central core. Of these there are three principal ones near each margin. Two of these, at each margin, have definite outlines; the other, at least at first, is somewhat indefinite. In some sections they are oblong, the largest about 0.01^{mm} in diameter; in others they are nearly circular and as much as 0.016^{mm} in diameter. These longitudinal vessels appear first in sections immediately behind the contractile bulbs, before the inner core is differentiated.

Anatomy of posterior segments.—In my former account of this species I stated that the female genital aperture is lateral. In this I was mistaken, being misled by the median lateral aperture for the escape of ova. A few segments were stained and cut into thin sections. In them the vagina was traced from the ovary forward along the median line, where it lay as a small tube, with short sinuous curves, to the base of the cirrus bulb. It there turns abruptly towards the margin, and in some can be traced for a short distance behind the cirrus bulb. It very soon passes to the side of the bulb, and consequently in longitudinal sections disappears from view. The cirrus emerges not exactly on the margin but a little way from the margin. The vagina appears to open immediately beside the cirrus, between it and the margin, or, what is more probable, the vagina and cirrus have a common marginal cloaca. In some sections, which passed diagonally through the segment, the tube of the vagina was seen lying close beside the cirrus bulb and near its outer extremity. The cirrus, in these sections, is seen as a slender, convoluted tube lying in the elongated bulb. The vas deferens is a much convoluted tube, which lies in an irregular or pyriform mass in front of the ovary. It enters the base of the cirrus bulb near the anterior edge of the segment. The ovary is centrally situated, about .36^{mm} broad and .16^{mm} long. In some of the sections it seemed to be made up of elliptical lobules, each containing a number of polygonal, often nucleated cells, each of the latter about .008^{mm} in diameter.

In segments which did not contain ova the walls are quite muscular.

They consist of an outer layer of fine muscular fibers crossing the longitudinal fibers of an inner layer at right angles. Beneath this there is a fine granular layer, with a few longitudinal fibers. Some of the granules of this layer are distinctly nucleated. In sections of some of the segments there is a layer of longitudinal muscles in which the fibers are arranged in rather thick parallel fascicles. The interior of the immature segments is, in great part, filled with the oval or elliptical spermatic capsules, .03 to .06^{mm} in diameter, and containing granular cells, some of which are nucleated, from .025 to .005^{mm} in diameter.

Sections of ripe segments show the entire segment to be filled with ova, with the exception of a small space in the center, which is occupied by the remnant of the ovary, and one of the anterior corners into which the cirrus bulb is crowded. The ova are yellowish in color, with unstained granular contents, measuring about .014^{mm} in diameter, and for the most part with an extremely irregularly collapsed membranous shell. Some ova were found near the margin in which the shells were entire, and were then seen to be very thin and delicate and separated by a clear space from the granular interior. These measured from .028^{mm} to .038^{mm} in diameter, and the granular contents .022^{mm} in diameter.

The ova occur in these segments in enormous numbers. They fill the segment to its extreme outer margins. The division between the mass of ova of two adjacent segments was found to be reduced to a thin partition .008^{mm} thick. The marginal walls of the segments were reduced to about the same thickness.

SYNDESMOBOTHRIUM Diesing.

This genus is characterized by Diesing as follows: Body articulate tæniæform; neck tubular, rounded at the base; head tetragonal, with four terminal prominent bothria attached to head by posterior margin, cruciformly disposed, oval, slightly convex, joined with each other at the base by a membrane; proboscides four, filiform, armed, each one running through a bothrium (pedicel) excurrent at apex, long, retractile in the neck. Genital apertures marginal (?). In intestines of marine fishes of tropical America.

Syndesmobothrium filicolle, sp nov.

[Plate XV. Figs. 2-4.]

A single specimen belonging to the genus *Syndesmobothrium*, without mature segment, the neck attached to a linear oblong body (blastocyst) and with the proboscides retracted was found in the spiral valve of a sting ray (*Trygon centrura*) in August, 1884, at Wood's Holl, Massachusetts.

This description is necessarily so meager that I have hesitated to bestow a specific name on the specimen which furnishes the data for it.

The head is tetragonal transverse, cruciform. Bothria four, subcircular, convex, cup-shaped, each the termination of a short cylindrical pedicel. They are arranged in a cruciform manner, but also somewhat in pairs and capable of being directed either forward or backward in pairs. Proboscides very long and slender, each one running through a pedicel and emerging at the apex, apparently beside the bothrium proper. Neck very long and slender, cylindrical, enlarging slightly at the contractile bulbs and rounded at the base, tapering to a point, where it is connected with the body (blastocyst); proboscis-sheaths spiral, contractile bulbs linear oblong; hooklets long and slender, falcate; blastocyst linear oblong, a little longer than the head and neck.

Dimensions of alcoholic specimen, somewhat flattened: Length of head and neck, 4.60^{mm}; length of blastocyst, 5.25^{mm}; diameter, 0.76^{mm}; breadth of head, about 0.50^{mm}; diameter of bothrium, 0.12^{mm}; diameter of pedicel, 0.14^{mm}; diameter of neck, 0.14 to 0.30^{mm} at contractile bulbs; length of proboscides about 3^{mm}; length of contractile bulbs, 0.84^{mm}; breadth, 0.08^{mm}.

The proboscides were retracted but the hooks could be seen through the transparent neck. At the base of the proboscides they were about 0.032^{mm} in length; near the middle of the proboscides they were 0.06^{mm} long, with basal supports as much as 0.03^{mm} wide. The hooks appear to be of pretty uniform shape; being long, slender, recurved, falcate, with rather broad basal supports.

I have met with encysted forms similar to this in various species of the *Teleostei* such as *Pomatomus saltatrix*, *Cybium regale*, etc. One from the Spanish mackerel (*Cybium regale*) was described by me in the American Naturalist for February, 1887, under the name of a larval *Tetrarhynchobothrium*.

Family V.—TÆNIÆDÆ.

Tetracotyleidæ Diesing.

PARATÆNIA, gen. nov.

Body tæniæform, articulate. Head subglobose, with four small opposite, sessile bothria. Terminal os and sixteen protractile tentacular proboscides. Genital apertures marginal.

This form appears to be related to the genus *Tænia*. The tentacular proboscides are probably homologues of the proboscis of avian *Tæniædæ*.

43 *Paratænia medusia*,* sp. nov.

[Plate XV, Figs. 5–9.]

Head somewhat globose but variable according to state of contraction, wider than strobile. Bothria four, small, sometimes papilli-

* The reference of this species to the *Tæniædæ* is provisional. Certain structural peculiarities suggest the propriety of referring it to the *Tetrabothriidæ* near *Echeneibothrium*.

form. Circular os at apex of head from which sixteen soft tentacle-like proboscides may be protruded. Neck none. First segment short; succeeding segments often moniliform, then lengthened; last segments four or five times as long as broad, loosely attached to each other. Genital apertures marginal; cirrus echinate, ova numerous with thin membranous shell. Strobile small, so far as observed not exceeding 6^{mm}.

Habitat.—Trygon centrura, spiral valve, August 1, 3, and 10, 1887. Wood's Holl, Massachusetts.

During the month of July and August, 1887, I made careful and painstaking search for entozoa in the sting ray (*Trygon centrura*). On three different occasions, in the course of these examinations, I found a few small cestods in the spiral valve which I at first took to be fragments or immature forms of some of the various species of the *Tetrabothriidæ* which I found at the same time in most of these hosts. On one occasion, however, I examined a sting ray which yielded no entozoa except these small forms, a very minute *Rhynchobothrium* and a few cysts from the stomach wall. When these small cestods were examined, while they were yet alive, they showed no signs of activity in the sea-water in which they had been placed, and as the short chains of segments all exhibited a tendency to fall to pieces readily, the idea was naturally suggested that they were *Tetrabothriidæ* which had been introduced into the ray in a mature condition along with their proper host and had succeeded in resisting the action of the digestive fluids of the ray for a while, but were now succumbing to the influence of their uncongenial surroundings.

On account of the number of larger and more attractive new species that were collected at the same time, these very small and apparently unpromising forms were given but a superficial examination at first. I found, however, that they possessed four bothria or acetabula and a terminal opening at the apex of the head. It was only after the specimens had lain for some time in alcohol and I had leisure to study them carefully that their true nature was revealed. One is tempted, when doing systematic work on any group, to pronounce each new form that meets his eyes the most remarkable of all. I have become accustomed to having my first notions, with regard to these soft-bodied forms, rudely shaken by more careful subsequent study, but I think I have never encountered any forms of entozoa that have proved to be so different from first conceptions as these have done.

In the first place the worms are quite small. The longest living specimen that was measured was less than 5^{mm}. They must grow somewhat longer than this, however, as an alcoholic specimen has been found which measured 6^{mm}. The chains of joints that remain attached to the heads of alcoholic specimens are few of them as much as 2^{mm} in length. The head is of various shapes. When the tentacular probos-

cides are retracted it is usually globular, often truncated at the apex. Again it may be elongated glandiform or pyriform on account of a constriction behind the bothria.

The bothria, four in number, are opposite and of varied appearance. In some cases they are sessile and difficult to see, in others they are elevated on low papillæ. The latter usually stand at right angles to the axis of the body, although in cases where the proboscides are retracted, they are sometimes directed forward. In one case they were so arranged as to give to the head a decidedly cuboidal shape. In this case the diameter of the head was .36^{mm}, the outside diameter of a tubular bothrium was .08^{mm}, the inside diameter .04^{mm}. Seen from the front the bothria made the four corners of a square. The bothria are sometimes on the anterior part of the head, this of course only when the proboscides are retracted, sometimes about the middle.

The most remarkable changes take place in the head when the tentacular proboscides are protruded in whole or in part; these proboscides are sixteen in number; among the lot of thirty specimens, more or less, there were fortunately four or five which had the proboscides protruded, and of this number two at least in which they were fully protruded so as to form a terminal rosette-like cluster, made by the sixteen radiating tentacular-like proboscides. It is probable that these organs can be extended farther than was indicated in the alcoholic specimens. In one specimen the head was .5^{mm} in length, including the terminal rosette; diameter of head behind bothria, .16^{mm}; diameter of rosette, .34^{mm}; length of bothrial papilla about .06^{mm}; diameter of first segment .06^{mm}.

Only a few of the more frequent shapes which these scolices assume have been mentioned, but enough have been alluded to which, together with the sketches, should make future identifications reasonably certain. It is to be hoped that the polymorphous character of the head of this species may not be made the occasion of multiplying species unnecessarily.

An illustration is here afforded of the importance of preserving every specimen, and of not neglecting what may appear to be unimportant fragments. It is certainly possible to have obtained one-half of the specimens of this species that are in my collection without finding any that show the real structure of the head.

The proboscides are soft, tentacle-like, slender when fully extended; they are probably extended by evagination, although of this fact I am not yet certain; when all are fully extended they are found to be exactly sixteen in number, and form a terminal crown or rosette; in this condition they resemble the expanded tentacles of a sea-anemone. Sometimes only a few of these tentacles are protruded, and in one instance a single tentacle arose from the apex of the head and was surrounded closely by the four bothria; if found by itself it would have been a puzzle indeed and might have furnished the type of a new species. The longest tentacle that was observed measured .2^{mm} in length, and was

.02^{mm} in diameter at base. When the tentacles are retracted, the head is terminated by a circular opening; the sheath or cavity in which the retracted tentacles lie sometimes extends to, and sometimes beyond, the bothria; at other times it is wholly in front of the bothria, in which cases the anterior part of the head is prolonged; in one case the length of the head was .34^{mm} and the depth of the sheath .18^{mm}.

The largest alcoholic specimen yielded the following measurements: Length, 6^{mm}; length of head, .28^{mm}; diameter of head, .23^{mm}; diameter of first segment, .12^{mm}; length of last segment, 1.8^{mm}; breadth, .22^{mm}. The length of the head in a living specimen was .48^{mm}, length of strobile 4.8^{mm}. In most of the specimens the first distinct segments begin immediately behind the head. In some, however, there is a slight obscuration of the first segments on account of differences of contraction. In the latter cases the first segments have the appearance of a short neck and are broader than in those cases where the first segments are distinct.

In the measurement of ten alcoholic specimens the maximum length of head was .5^{mm}, minimum .22^{mm}, average .314^{mm}; maximum breadth .36^{mm}, minimum .24^{mm}, average .276^{mm}. The average length of first segment in these specimens was .038^{mm}, maximum .04^{mm}, minimum .02^{mm}, while in three of the specimens they were obscure. The average breadth of the first segment was .09^{mm}, maximum .16^{mm}, minimum .06^{mm}.

Usually the first two or three segments are quite short and crowded together, while these are succeeded by a few rounded segments which impart to that part of the strobile a moniliform appearance. The succeeding segments increase in length rapidly, are distinctly separated from each other, and become detached easily. Very often there is a distinct constriction near the anterior end, with a corresponding swelling in the middle. The posterior mature segments are much elongated. In one specimen the last two proglottides, which are filled with ova, are together almost as long as the remainder of the strobile. The shape of the mature segments is quite characteristic. They are elongated, arcuate, of nearly uniform breadth throughout, except at a point near the anterior end, where they are narrowed by a neck-like constriction. They are rounded, blunt, and slightly swollen at each extremity. Ova fill the interior completely, with the exception of the cirrus and its bulb, the only part of the genitalia that persists in the mature segments, to within .28^{mm} of the anterior end, where the uterine cavity stops abruptly, being limited by a transverse partition. The interior of the segment is, indeed, converted into a sac for containing ova. The anterior end of the mature segment in front of the transverse partition appears to be composed of the muscular walls alone. It probably retains some contractile power, and serves as a kind of locomotive organ for the free proglottis.

The ova consist of globular masses of granules or nuclei, surrounded by a thin transparent envelope, which is sometimes collapsed and irregu-

lar in outline. The diameter of the granular or nuclear masses ranges from .02 to .027^{mm}, that of the entire ovum from .03 to .05^{mm}. In one case, in a stained segment, there were observed among these granular masses with the transparent envelope a small cluster of amber-colored collapsed shells of ova about .036 and .022^{mm} in the two diameters.

The cirrus was invaginated in every case, but could be plainly seen through the walls of the segment when the latter were rendered transparent in glycerine. The retracted cirrus is pyriform in shape, the inner end is the larger, directed anteriorly and a little toward one of the lateral sides. It is very thickly beset with fine bristles. It measured .094^{mm} in length, and .05^{mm} in diameter, narrowing to .02^{mm} near the external aperture. The external opening of the cirrus is near the margin, about the middle of the segment. In the posterior mature segments, which were apparently slightly distorted, the genital aperture was situated from the margin a distance equal to one-fourth the breadth of the segments.

The ovaries are elongated, glandular, paired organs lying near the posterior end of the segment, one on each side of the median line. The vagina appears to open beside the cirrus on its posterior side. This fact, however, requires further verification. In segments which precede the mature ova bearing segments the retracted cirrus was seen to lie nearly transverse to the axis, inclined a little forward at the inner end, and equal in length to about three-fifths of the segments.

The testes are represented by a few globular or oval bodies lying along the middle line from the front end of the ovaries to the anterior end of the segment. These range in diameter from .055^{mm} in some specimens to over .08^{mm} in others. One of the largest of these oval testicles measured .086 and .047^{mm} in its two diameters. In those segments in which the testes are best developed the ovaries are scarcely at all developed. Furthermore, the transition from segments with large testicles and incipient ovaries, to those in which the interior is completely filled with ova, is quite abrupt.

The exceeding smallness of this anomalous worm has doubtless caused it to be overlooked heretofore, while the extreme variability of the head might easily lead collectors to regard it as simply fragmental remains of other and larger cestods with which the sting ray abounds.

List of the Entozoa described in this paper, and their hosts.

No.	Entozoa.	Host.	Page.	Plate.	Figures.
1	*Dibothrium restiforme* sp. nov	*Tylosurus caribbæus*	......	I	1–16
2	*Dibothrium manubriforme* Lt	*Tetrapturus albidus. Histiophorus gladius.*	......	......	......
3	*Dibothrium punctatum* Rud	*Limanda ferruginea. Lophopsetta maculata.*	......	II	1–4
4	*Dibothrium microcephalum* Rud	*Mola rotunda*	......	II	5–18
5	*Dibothrium plicatum* Rud	*Xiphias gladius*	......	III	1–6
6	*Dibothrium rugosum* Rud	*Gadus morrhua*	......	III	7–10
7	*Anthobothrium laciniatum* sp. nov	*Carcharias obscurus*	......	III	10–13
			......	IV	1–3
8	*Anthobothrium pulvinatum* sp. nov	*Trygon centrura*	......	IV	4–9
			......	V	1–2
9	*Echeneibothrium variabile* sp. nov	*Raia erinacea*	......	......	......
10	*Rhinebothrium flexile* gen. et sp. nov	*Trygon centrura*	......	V	3–5
11	*Rhinebothrium cancellatum* gen. et sp. nov.	*Rhinoptera quadriloba*	......	V	6–8
12	*Rhinebothrium longicolle* gen. et sp. nov	*Myliobatis freminvillei*	......	VI	1–4
13	*Spongiobothrium variabile* Lt	*Trygon centrura*	......	......	......
14	*Discocephalum pileatum* gen. et sp. nov	*Carcharias obscurus*	......	X	1–7
15	*Phyllobothrium foliatum* sp. nov	*Trygon centrura*	......	VI	5–10
16	*Anthocephalum gracile* gen. et sp. nov	*Trygon centrura*	......	VII	1–2
17	*Orygmatobothrium angustum* Lt	*Carcharias obscurus*	......	VII	3
18	*Crossobothrium laciniatum* Lt	*Odontaspis littoralis*	......	VII	4
19	*Lecanicephalum peltatum* gen. et sp. nov	*Trygon centrura*	......	IX	2–4
20	*Tylocephalum pingue* gen. et sp. nov	*Rhinoptera quadriloba*	......	IX	5–9
21	*Calliobothrium verticillatum* Rud	*Mustelus canis*	......	......	......
22	*Calliobothrium eschrichtii* Van Ben	*Mustelus canis*	......	VII	5–12
23	*Acanthobothrium paulum* sp. nov	*Trygon centrura*	......	VIII	1–7
24	*Phoreiobothrium lasium* Lt	*Carcharias obscurus*	......	......	......
25	*Platybothrium cervinum* gen. et sp. nov	*Carcharias obscurus*	......	VIII	8–10
			......	IX	1
26	*Thysanocephalum crispum* Lt	*Galeocerdo tigrinus*	......	X	8–9
27	*Rhynchobothrium bulbifer* Lt	*Mustelus canis*	......	XI	1–2
28	*Rhynchobothrium tumidulum* sp. nov	*Mustelus canis*	......	XI	3–11
29	*Rhynchobothrium hispidum* sp. nov	*Trygon centrura*	......	XI	12–17
30	*Rhynchobothrium longispine* sp. nov	*Trygon centrura*	......	XI	18–20
31	*Rhynchobothrium tenuispine* sp. nov	*Trygon centrura*	......	XII	1–2
32	*Rhynchobothrium heterospine* sp. nov	*Mustelus canis*	......	XII	3–6
33	*Rhynchobothrium imparispine* sp. nov	*Raia erinacea*	......	XII	7–9
34	*Rhynchobothrium wagneri* sp. nov	*Trygon centrura*	......	XII	10–12
35	*Rhynchobothrium lomentaceum* Dies	*Mustelus canis*	......	XIII	1–3
36	*Rhynchobothrium longicorne* sp. nov	*Odontaspis littoralis*	......	XIII	4–8
37	*Otobothrium crenacolle* gen. et sp. nov	*Sphyrna zygæna*	......	XIII	9–15
			......	XIV	1–4
38	*Tetrarhynchus tenue* sp. nov	*Trygon centrura*	......	XIV	5–6
39	*Tetrarhynchus robustum* sp. nov	*Trygon centrura*	......	XIV	7–9
40	*Tetrarhynchus bisulcatum* Lt	*Carcharias obscurus*	......	XIV	10–12
			......	XV	1
41	*Syndesmobothrium filicolle* sp. nov	*Trygon centrura*	......	XV	2–4
42	*Paratænia medusia* gen. et sp. nov	*Trygon centrura*	......	XV	5–9

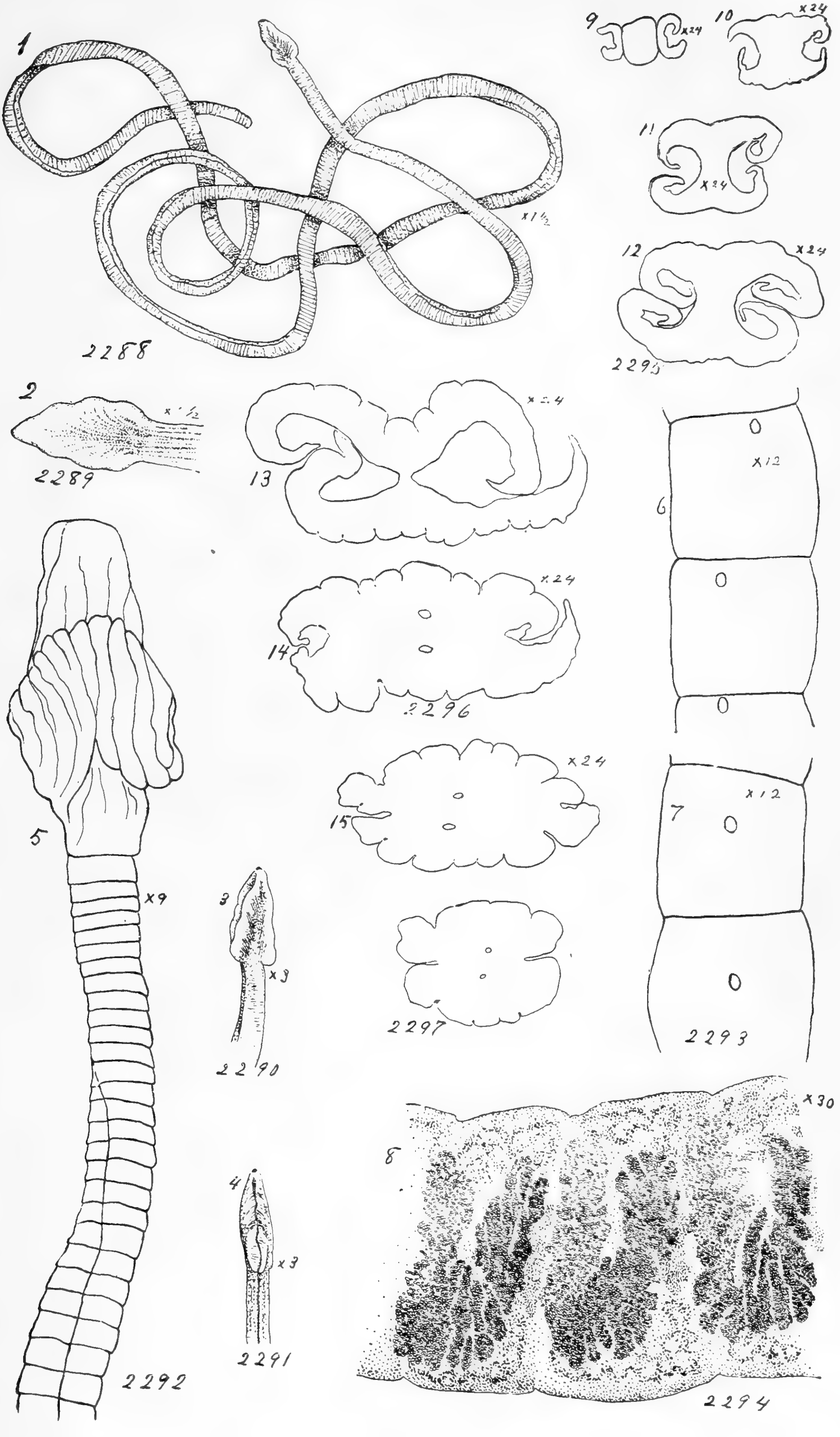
WASHINGTON AND JEFFERSON COLLEGE,
Washington, Pa., October 6, 1888.

PLATE I.

***Dibothrium restiforme*, sp. nov.**

FIG. 1. Adult strobile, from life, × 1½.
FIG. 2. Lateral view of head, from life, × 4½.
FIG. 3. Another view of head, from life, × 3.
FIG. 4. Marginal view of head, showing continuation of fossa into beginning of lateral groove, from life, × 3.
FIG. 5. Head and anterior part of body, from alcoholic specimen, × 9.
FIG. 6. Outline of mature segments, showing position of uterine aperture, × 12.
FIG. 7. Outline of same, showing opposite side of strobile with genital aperture, × 12.
FIG. 8. Posterior segments with ova, from alcoholic specimen, × 30.
FIG. 9–16. Outline of transverse sections of head, each magnified about 24 diameters. Fig. 9, section near apex; Figs. 10–12, sections between apex and middle; Fig. 13, about middle of head; Figs. 14 and 15, between middle and base; Fig. 16, at base of head behind fossæ. The lateral grooves appear at the margins of the sections.

All figures made by Margaret B. Linton.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x 1½
2288
2
x 1½
2289
9
x 24
10
x 24
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x 24
12
x 24
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13
x 24
14
x 24
2296
15
x 24
2297
6
x 12
7
x 12
2293
5
x 9
2292
3
x 3
2290
4
x 3
2291
8
x 30
2294

PLATE II.

Dibothrium punctatum Rud.

FIG. 1. Lateral view of head and first segments, from life, × 27.
FIG. 2. Marginal view of same, from life, × 27.
FIG. 3. Lateral view of head, alcoholic specimen made transparent in oil of cloves × 22.
FIG. 4. Posterior part of strobile, showing characteristic grouping of segments, × 6.

Dibothrium microcephalum Rud.

FIG. 5. *Var. a*, marginal view of head and first segments, from alcoholic specimen, × 24.
FIG. 6. Posterior end of strobile of same. × 15.
FIG. 7. *Var. β*. Marginal view of head and first segments, from alcoholic specimen, × 24.
FIG. 8. Outline of posterior segments of same, × 4.
FIG. 9. The same enlarged, showing ova, × 15.
FIG. 10. Transverse sections near middle of body; *a*, ovary; *b*, vas deferens; *c*, testes; *d*, cirrus bulb and cirrus; *e*, layer of longitudinal muscle fascicles; *f*, ova, × 33.
FIG. 11. Collapsed ova, × about 200.
FIG. 12–18. Transverse sections of head, × 24; Fig. 12, near apex, showing cut ends of longitudinal muscles with a few transverse muscles; the beginnings of fossæ are indicated by crescent-shaped clear spaces with their convexities turned toward each other; Fig. 13, transverse muscles more numerous, crossing each other at right angles, anterior ends of lateral fossæ clearly outlined; Fig. 14, sections near anterior end of head, behind apical cushion; Fig. 15, section near middle of head; Fig. 16, section towards base of bothria; Fig. 17, section near base of head, bothria no longer united with head; Fig. 18, section through first segment; an outer concentric ring is beginning to separate from the inner core to form the posterior salient border of the segment.

All figures made by Margaret B. Linton.

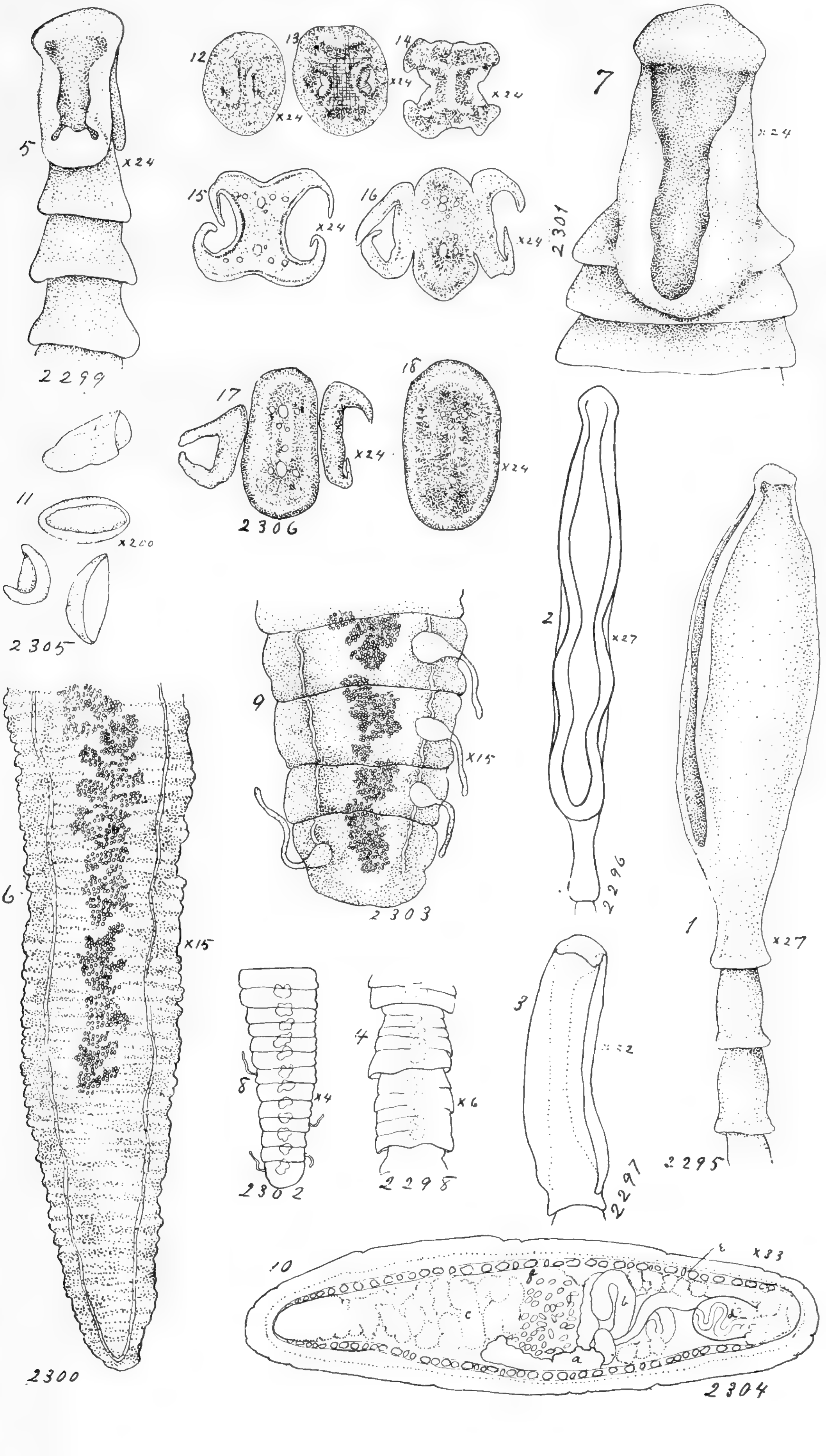

2299
2301
2306
2305
2296
2303
2300
2302
2298
2297
2295
2304

PLATE III.

Dibothrium plicatum Rud.

FIG. 1. Mature strobile after lying for a short time in sea water, from life, × 1½.
FIG. 2. Young specimen found wholly inclosed in a cyst-like cavity of the rectinal wall, from life, × 4.
FIG. 3. Lateral view of head of same, × 4.
FIG. 4. Posterior segments of adult strobile, from alcoholic specimen, × 10. The sketch was made from a segment made transparent in oil of cloves, *a*, cirrus and cirrus bulb. The relatively large ova are plainly seen through the transparent walls of the segment.
FIG. 5. Ovum, alcoholic, × about 200.
FIG. 6. Longitudinal section through the postero-median part of the strobile; *a*, *a*, cirrus bulbs in marginal prolongations; *b*, longitudinal muscles; *c*, ova; *d*, granular masses, presumably testes, × 15.

Dibothrium rugosum Rud.

FIG. 7. Longitudinal section through ripe segments; *a*, fascicles of longitudinal muscles; *b*, *b*, partitions separating adjacent segments; *c*, ova filling the interior of the segments; *d*, shred of connective tissue; other similar shreds are shown lying among the ova, × 21.
FIG. 8. Transverse section of a ripe segment; *a*, lateral aperture; *b*, *b*, layer of fascicled longitudinal muscles; *c*, shred of connective tissue extending into the interior of the segment which is filled with ova.
FIG. 9. Transverse section of antero-median segment, near the point where the ova first appears; *a*, position of cirrus and its bulb; *b*, vas deferens; *c*, *c*, layer of fascicled longitudinal muscles.
FIG. 10. Ova, alcoholic, × 200.

Anthobothrium laciniatum, sp. nov.

FIG. 11. Var. *filicolle*, head and neck from life, × 34.
FIG. 12. Var. *brevicolle*, head and neck from life, × 38.
FIG. 13. Var. *filicolle*, front view of head, compressed, from life, × 42.
All the figures made by Margaret B. Linton.

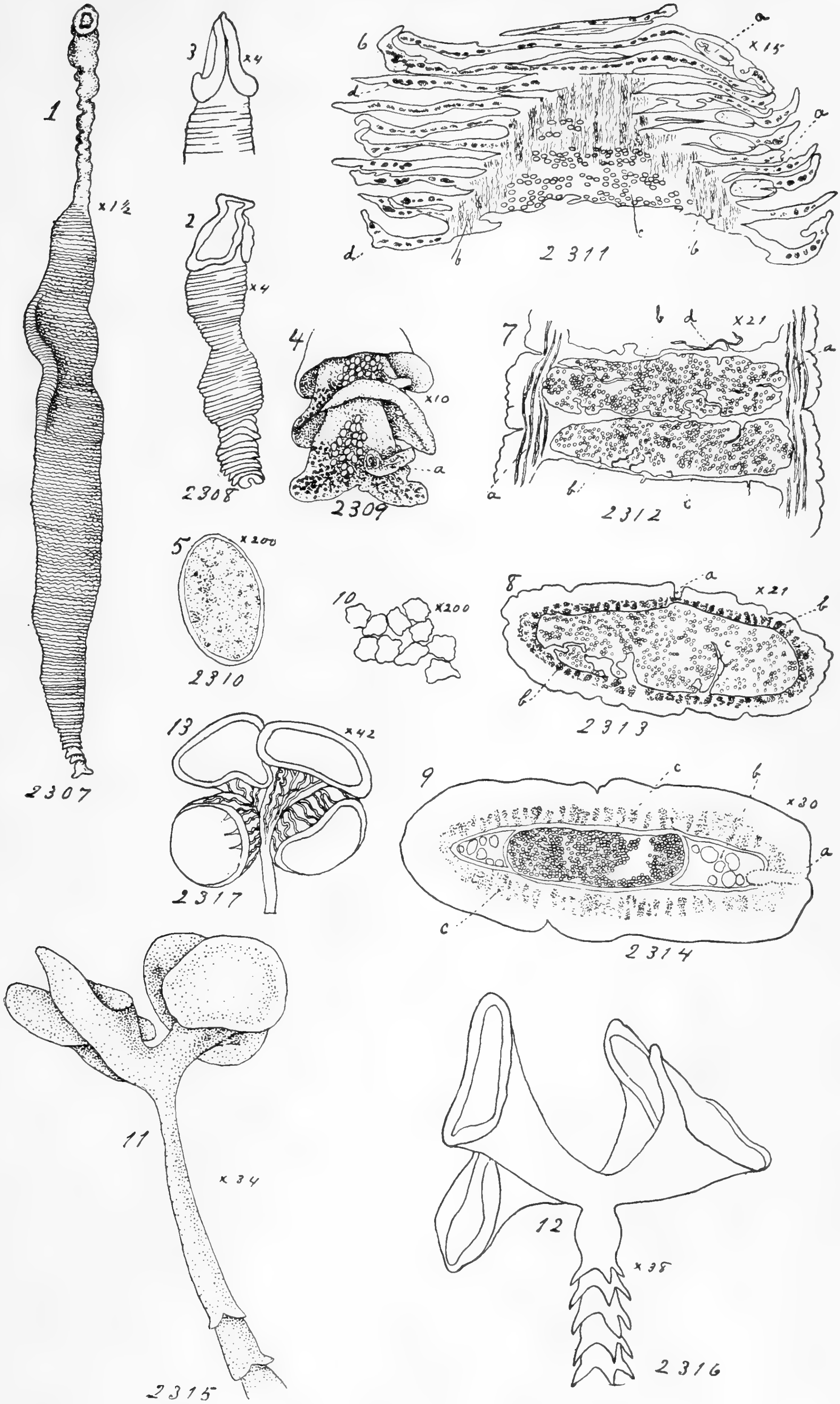

1
x 1½
2307
3
x 4
2
x 4
2308
4
x 10
2309
5
x 200
2310
6
x 15
2311
7
x 21
2312
8
x 21
2313
9
x 30
2314
10
x 200
11
x 34
2315
12
x 38
2316
13
x 42
2317

PLATE IV.

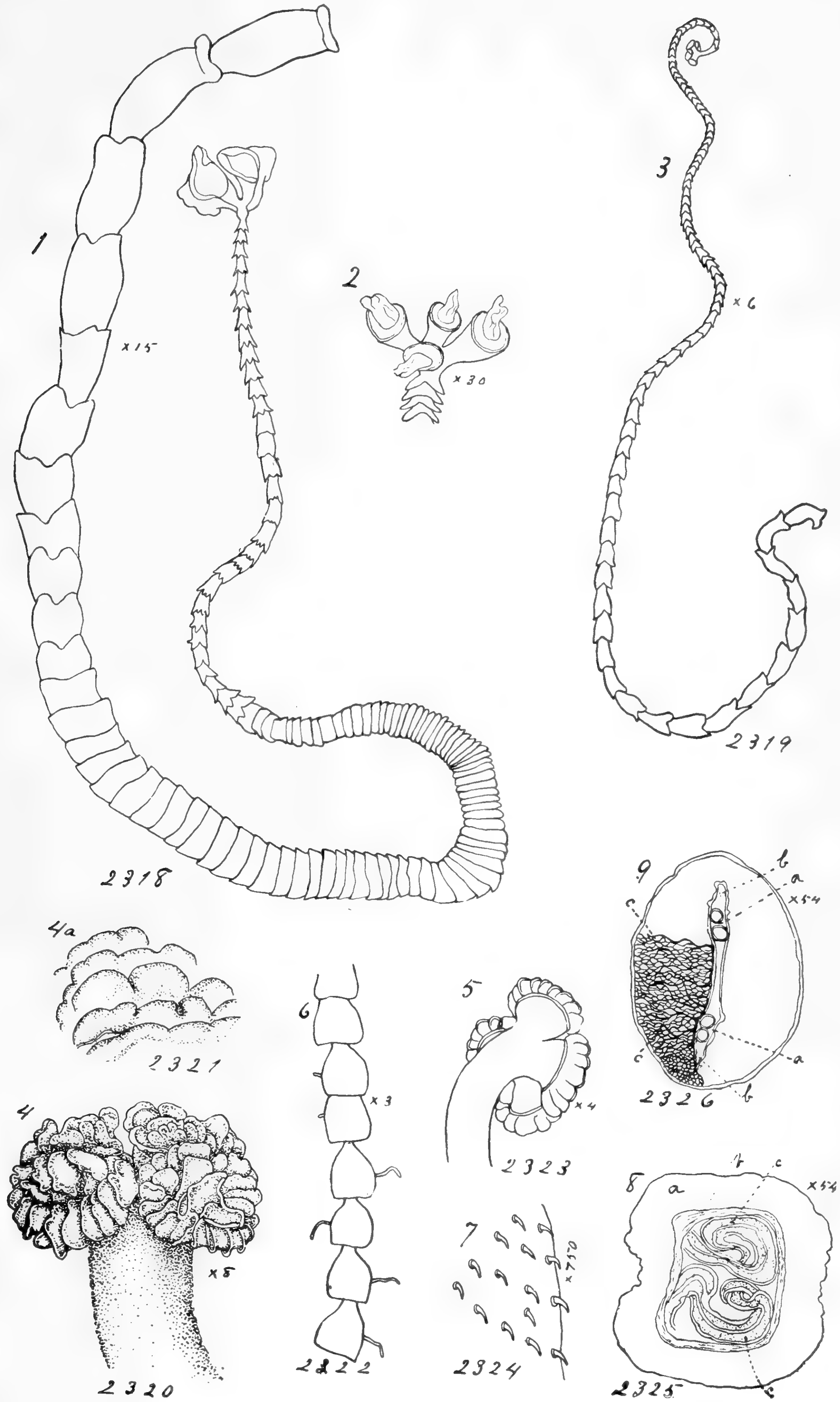
Anthobothrium laciniatum, sp. nov.

FIG. 1. Var. *brevicolle.* Outline of strobile, from life, × 15.
FIG. 2. Head of an alcoholic specimen with the thin faces of the bothria protruding, × 30.
FIG. 3. Outline of strobile, from life, an occasional form, × 6.

Anthobothrium pulvinatum sp. nov.

FIG. 4. Head and part of neck, lateral view, from life, × 8.
FIG. 4a. Part of face of bothrium of alcoholic specimen.
FIG. 5. View of head from behind, showing pedicels and cushion-like bothria, from life, × 4.
FIG. 6. Outline of posterior segments, from life, × 3.
FIG. 7. Spines of cirrus, from life, × about 750.
FIG. 8. Transverse section at base of head; *a*, thick layer, composed for the most part of longitudinal muscles, not shown in sketch; *b*, layer of circular fibers; *c*, *c*, the two pairs of aquiferous vessels, × 54.
FIG. 9. Transverse section a short distance back of head; *a*, *a*, aquiferous vessels; *b*, *b*, lateral nerves; *c*, *c*, part of connective tissue fibers seen in the section.

Figure 2 by the author, all others by Margaret B. Linton.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x 15
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2
x 30
3
x 6
2319
4a
2321
4
x 8
2320
6
x 3
2222
5
x 4
2323
7
x 750
2324
9
b
a
x 54
c
c
a
b
2326
8
a
4
c
x 54
c
2325

PLATE V.

Anthobothrium pulvinatum, gen. et sp. nov.

FIG. 1. Diagrammatic sketch of transverse section of head and pedicels of bothria; *a*, central nervous mass; *b b*, nerve masses of pedicels; *c*, *c*, commissures connecting central mass with masses of pedicels; *d*. *d*, nerves from nerve masses of pedicel to bothria; *e*, transverse muscles. Only a small part of the musculature is shown; *f f*, aquiferous vessels, × 40.

FIG. 2. Anatomy of mature segment as revealed in longitudinal section; *a*, vas deferens; *b b*, ovaries; *c*, shell gland; *d*, vagina; *e*, longitudinal muscles; *f*, cirrus, × 14.

Rhinebothrium flexile, gen. et sp. nov.

FIG. 3. Strobile, outline from life, details of last two segments filled in from alcoholic specimen, × 22.

FIG. 4. Head and neck of same, from life, × 45.

FIG. 5. Disposition of aquiferous vessels in neck and bases of pedicels, from life, compressed and greatly enlarged.

Rhinebothrium cancellatum, sp. nov.

FIG. 6. Head and neck, from life, × 36.

FIG. 7. Diagram of bothrium showing arrangement of loculi, × 45.

FIG. 8. Side view of single bothrium and its pedicel, outline from life, × 36.

Fig. 1, by the author, all others by Margaret B. Linton.

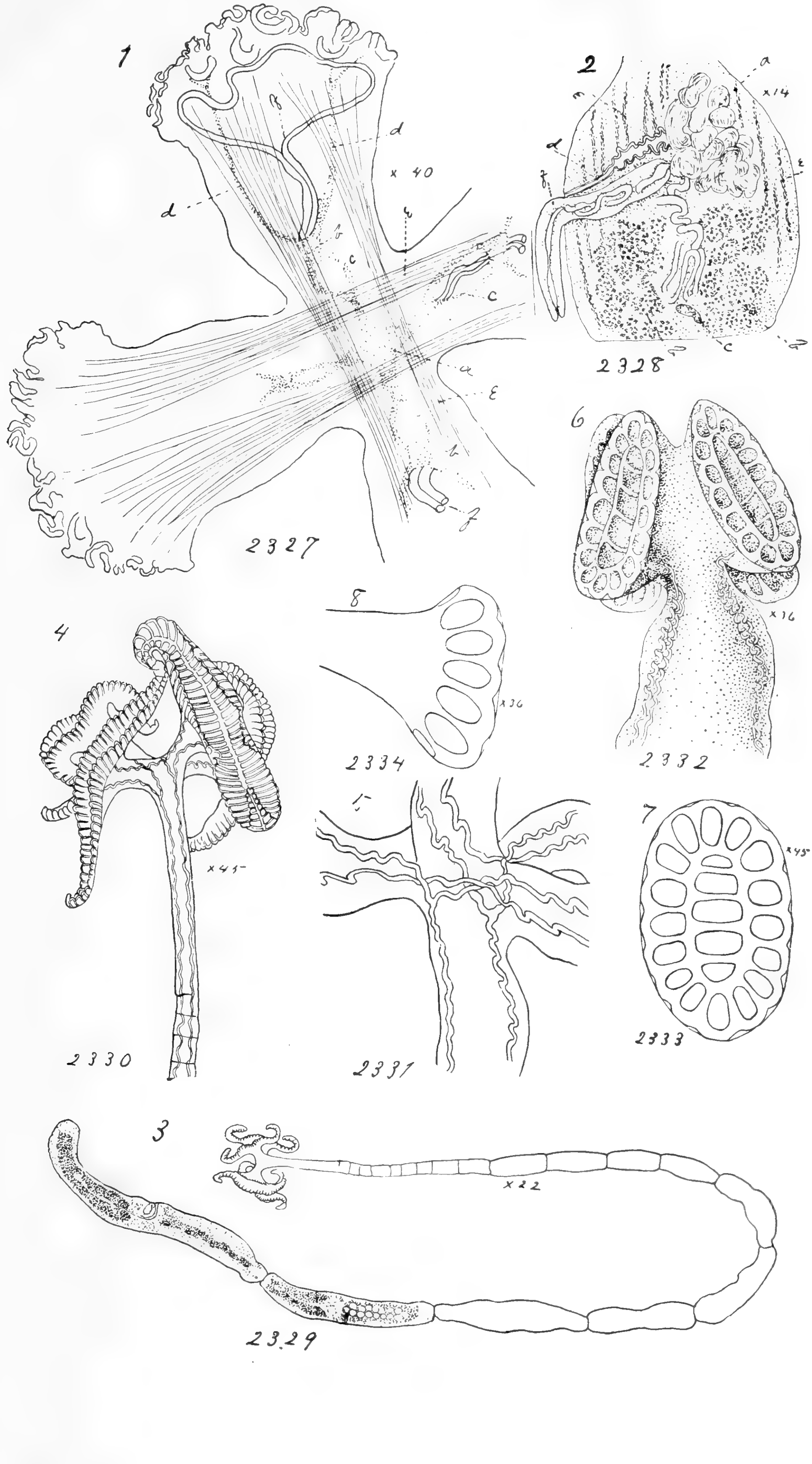

1
2327
x 40
2
2328
x 14
6
2332
x 16
8
2334
x 36
4
2330
x 45
5
2331
7
2333
x 45
3
x 22
2329

PLATE VI.

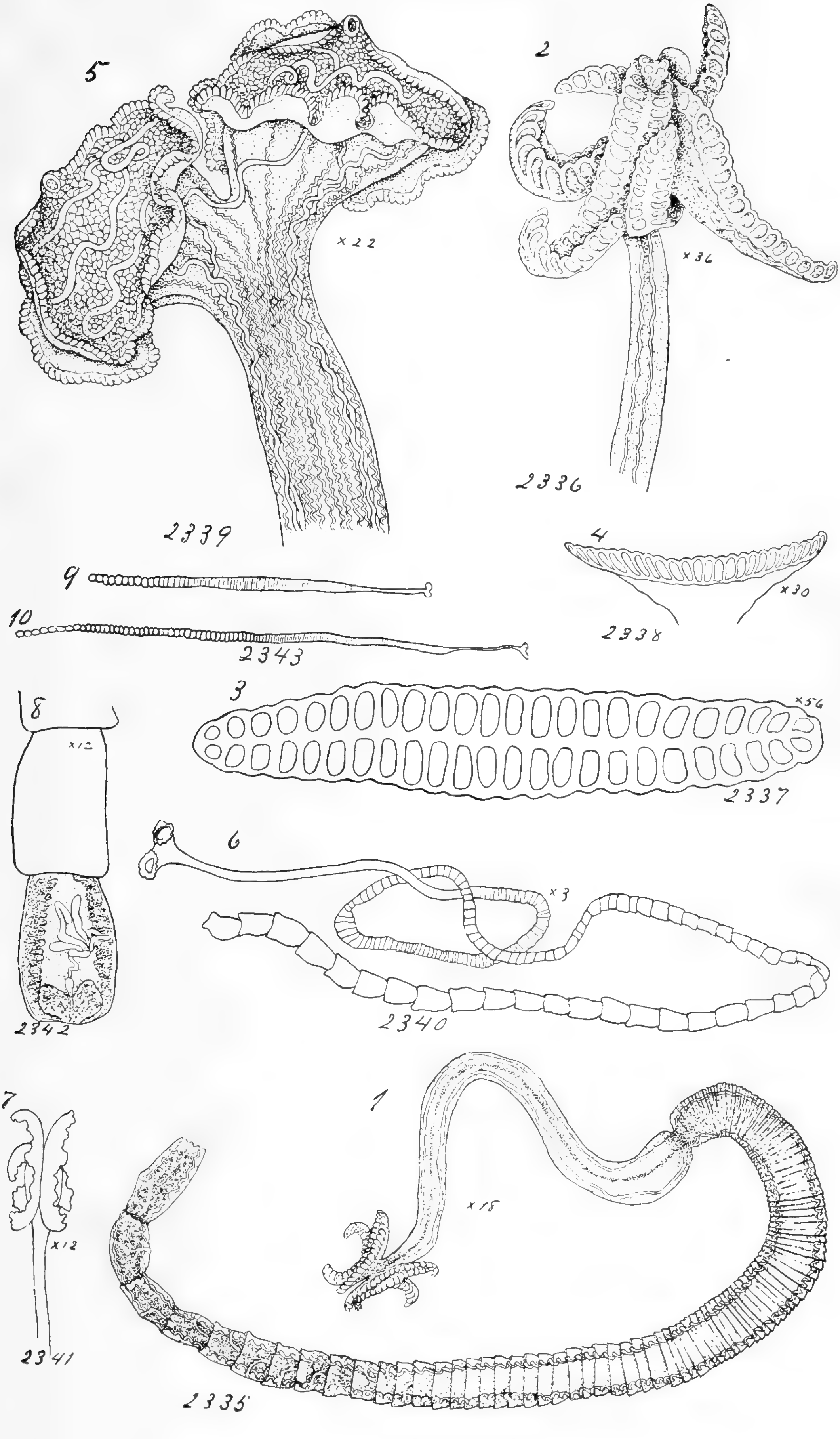
Rhinebothrium longicolle, sp. nov.

FIG. 1. Strobile, from life, × 18.
FIG. 2. Head and neck of same, × 36.
FIG. 3. Diagram of bothrium showing plan of loculi, × 56.
FIG. 4. Side view of bothrium with its pedicel, from life, × 30.

Phyllobothrium foliatum, sp. nov.

FIG. 5. Head and neck, lateral view, from life, × 22. In this sketch the aquiferous vessels in the neck and bothria, the spiral fascicles of muscles in the neck and pedicels and the reticulated faces of the bothria are shown.
FIG. 6. Strobile, outline from life, × 3.
FIG. 7. Marginal view of head and neck, outline from life, × 12.
FIG. 8. Posterior segments, from life, × 12.
FIG. 9. Strobile, from alcoholic specimen, usual form.
FIG. 10. Strobile with attenuated neck, from alcoholic specimen.

All the figures made by Margaret B. Linton.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2336
x 36
4
2338
x 30
9
10
2343
8
x 12
2342
3
x 56
2337
6
x 3
2340
7
x 12
2341
1
x 18
2335

PLATE VII.

Anthobothrium gracile, gen. et sp. nov.

FIG. 1. Head and neck of living specimen, × about 50.
FIG. 2. Head and neck of same individual in alcohol, × about 50.

Orygmatobothrium angustum Lt.

FIG. 3. Outline of head and neck, from life, × 21.

Crossobothrium laciniatum Lt., var. *longicolle.*

FIG. 4. Outline of strobile, from life, × 8.

Calliobothrium eschrichtii Van Ben.

FIG. 5. Head of living specimen, × 20.
FIG. 6. Bothrium with edges appressed, from life, × 20.
FIG. 7. Posterior segment, from life, × 30.
FIG. 8. Ovum undergoing segmentation, from life, × about 115.
FIG. 9. Another ovum, with granular stellate interior, also undergoing segmentation, from life.
FIG. 10. Outline of mature segment with ova issuing from the margin, from life.
FIG. 11. Outline of strobile, from alcoholic specimen, × 12.
FIG. 12. Hooks of a single bothrium, with part of the musculature, × 200.

All the figures made by Margaret B. Linton.

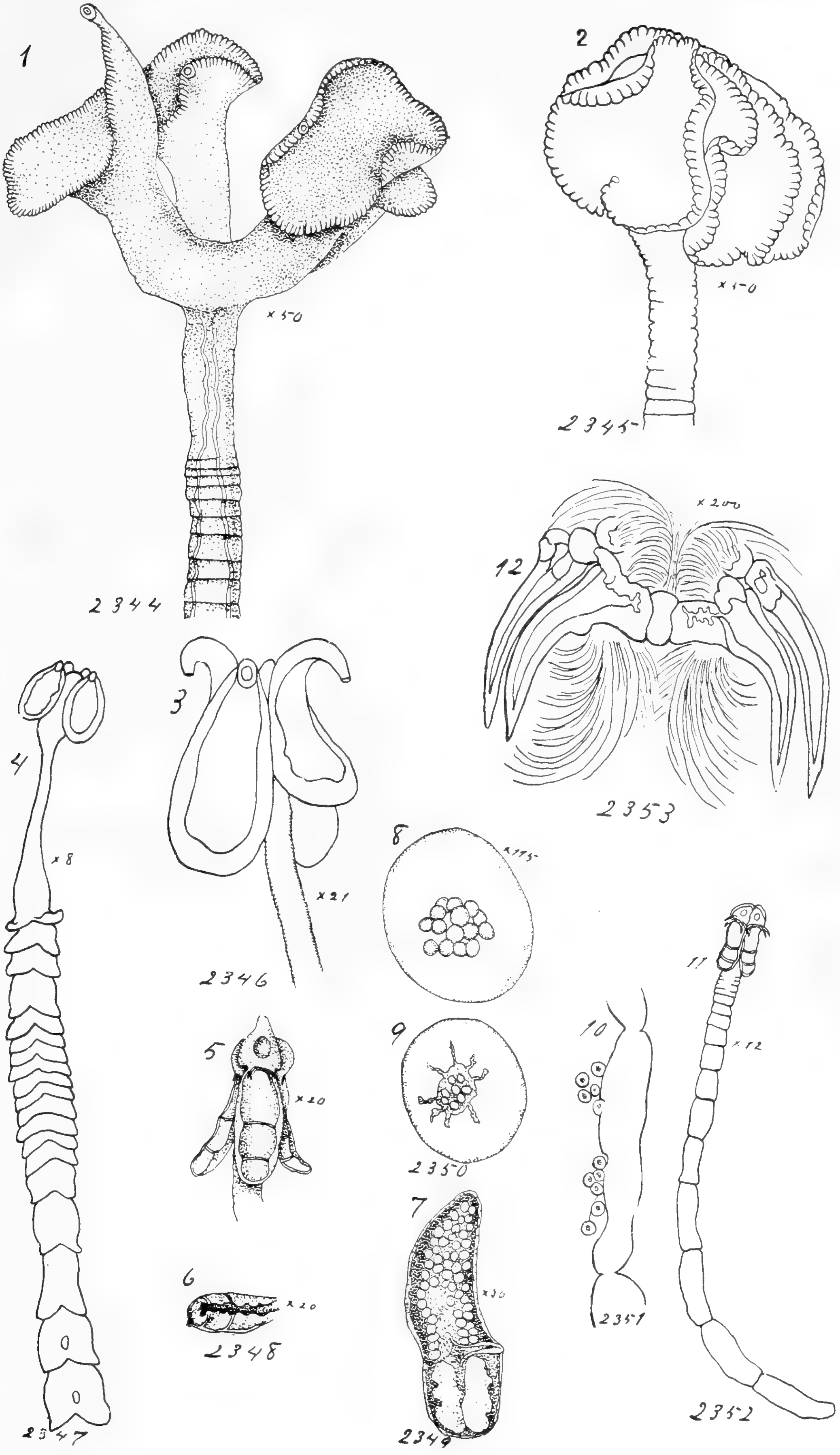

1
x 50
2344
2
x 50
2345
12
x 200
2353
4
x 8
2347
3
x 21
2346
5
x 20
6
x 20
2348
8
x 175
9
2350
7
x 30
2349
10
2351
11
x 12
2352

PLATE VIII.

Acanthobothrium paulum, sp. nov.

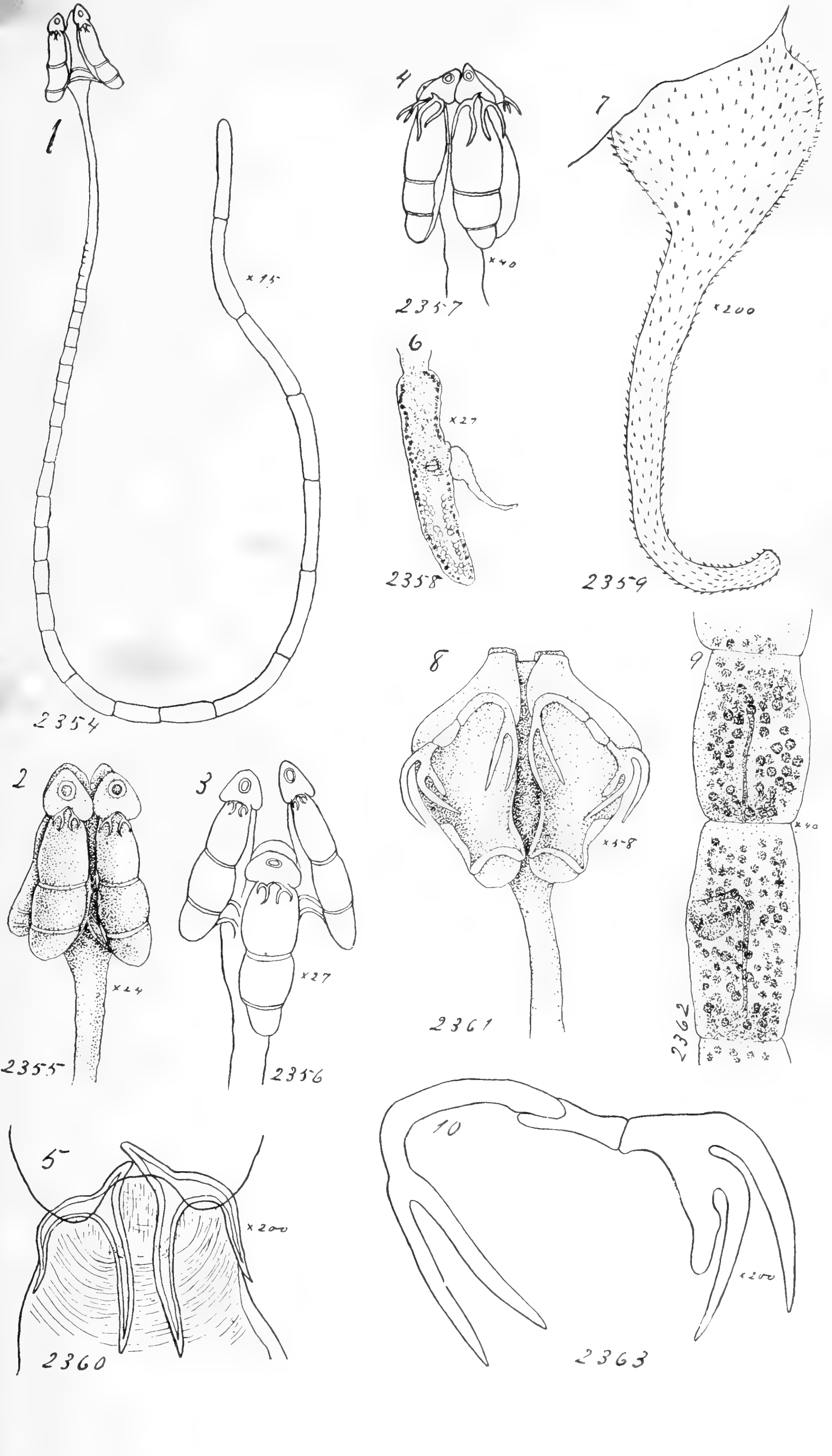
FIG. 1. Outline of strobile, from life, × 15.
FIG. 2. Head of same at rest, × 24.
FIG. 3. Same with one pair of bothria thrust forward, × 27.
FIG. 4. Head of alcoholic specimen, × 40.
FIG. 5. Hooks of a single bothrium with a part of the musculature, × about 200.
FIG. 6. Posterior segment with everted cirrus, from alcoholic specimen, × 27.
FIG. 7. Cirrus, × about 200.

Platybothrium cervinum, gen. et sp. nov.

FIG. 8. Head and neck of living specimen after it had lain in sea-water an hour or more. The head was very flat and thin, and semi-transparent, × 58.
FIG. 9. Posterior segments, in glycerine, × 40.
FIG. 10. Set of hooks belonging to a single bothrium, × about 200.

All the figures made by Margaret B. Linton.

PLATE VIII.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×40
2357
7
×200
2359
6
×27
2358
2
×24
2355
3
×27
2356
8
×58
2361
9
×40
2362
5
×200
2360
10
×200
2363

PLATE IX.

Platybothrium cervinum, gen. et sp. nov.

FIG. 1. Outline of living strobile, × 12.

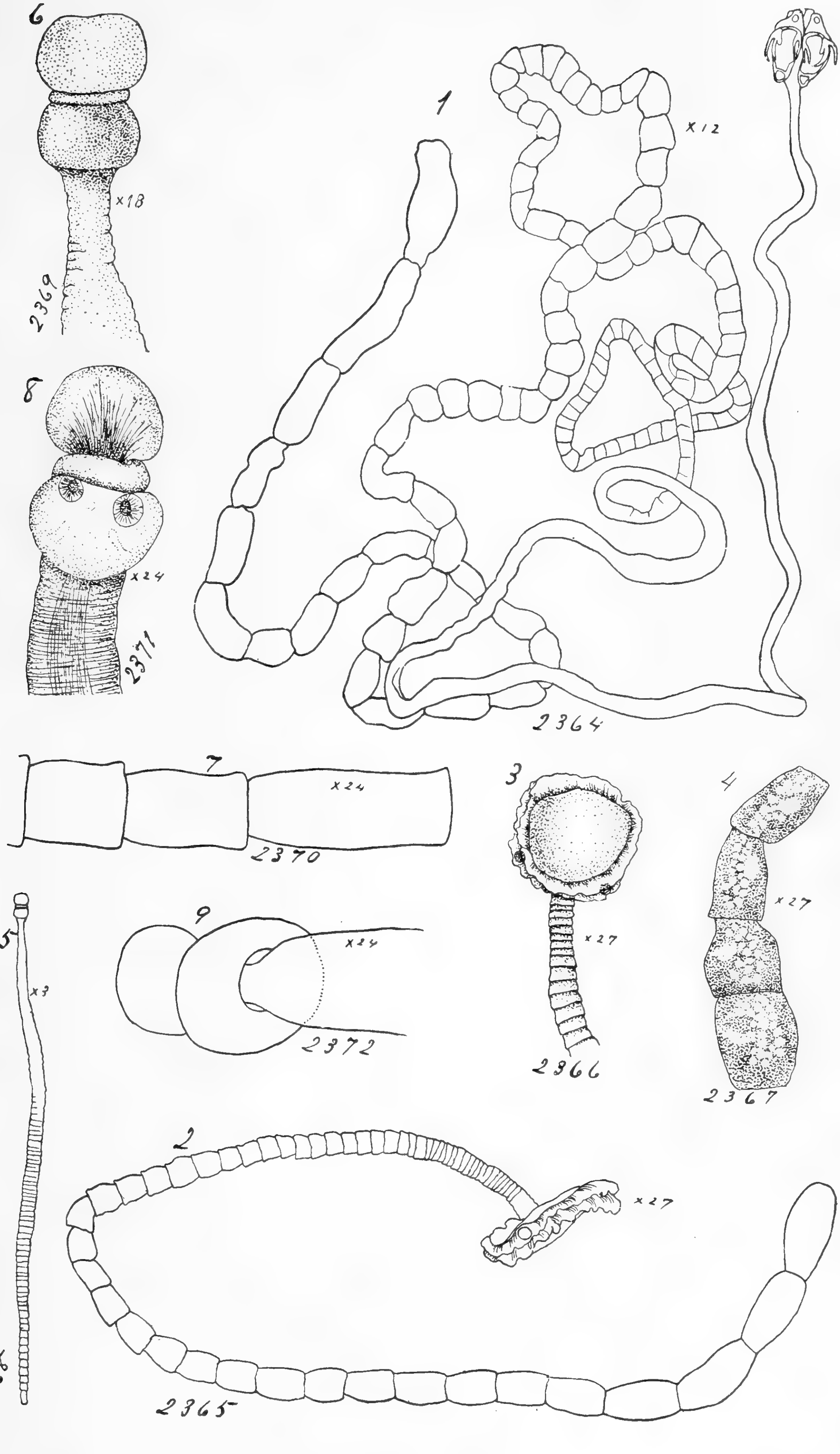
Lecanicephalum peltatum, gen. et sp. nov.

FIG. 2. Outline of living strobile, × 27.
FIG. 3. Top view of head of same, × 27.
FIG. 4. Posterior segments of same, compressed, × 27.

Tylocephalum pingue, gen. et sp. nov.

FIG. 5. Outline of living specimen, × 3.
FIG. 6. Head and neck of living specimen, × 18.
FIG. 7. Outline of posterior segments, × 24.
FIG. 8. Head and neck of same individual, when made transparent in oil of cloves, × 24.
FIG. 9. Outline of same, showing posterior part of head at its junction with the neck, × 24.

All the figures made by Margaret B. Linton.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x 18
2369
1
x 12
2364
8
x 24
2371
7
x 24
2370
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x 27
2366
4
x 27
2367
5
x 3
2368
9
x 24
2372
2
x 27
2365

PLATE X.

Discocephalum pileatum, gen. et sp. nov.

FIG. 1. Var. α. Head and neck, from life, $\times$ 9.
FIG. 2. Var. β. Head and neck of living specimen, $\times$ 9.
FIG. 3. Another view of the same, $\times$ 9.
FIG. 4. Outline of median segments, from life, $\times$ 6.
FIG. 5. Outline of posterior segments, from life, var. α, $\times$ 6.
FIG. 6. Outline of section through head, $\times$ 38.
FIG. 7. Section of mature segment, $\times$ about 8; *a, a*, ovaries; *b, b*, uterine cavities with clusters of ova; *b′, b′*, uterine cavities without ova; *c*, vagina; *d*, base of invaginated cirrus; *e, e*, convolutions of the vas deferens; *f, f*, testes.

Rhynchobothrium bulbifer Lt.

FIG. 8. Free proglottis, from life, $\times$ 15; *a*, bulb of cirrus partly protruding from margin of segment; *b*, vagina, near its exterior opening; *c*, enlargement of vagina into a receptaculum seminis; *d, d*, vessels of the water-vascular system; *e, e*, spermatic capsules of testes; *f*, cirrus bulb with vas deferens entering the anterior part of the inner extremity; *g, g*, ova: *h*, posterior coils of vas deferens.
FIG. 9. Cirrus of same everted with escaping spermatozoa, from life.

All figures made by Margaret B. Linton.

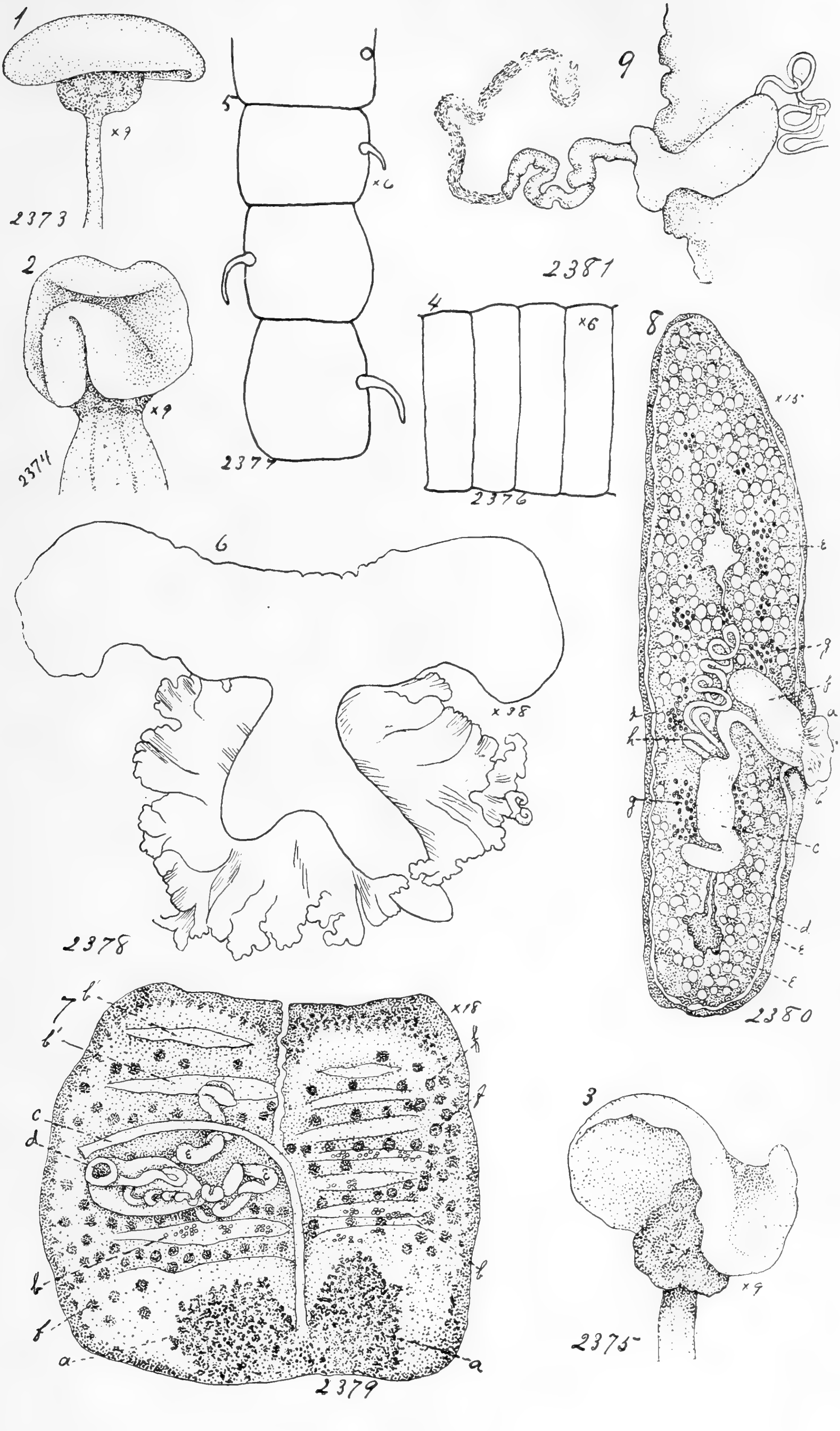

2373
2374
2376
2381
2378
2380
2379
2375

PLATE XI.

Rhynchobothrium bulbifer Lt.

FIG. 1. One view of proboscis, from young specimen, × about 400.
FIG. 2. Principal forms of larger hooklets, × about 400.

NOTE.—For additional figures of this species see U. S. Fish Commission Report for 1886, p. 508, Plate v. Figs. 17 and 18, under *R. tenuicolle.*

Rhynchobothrium tumidulum, sp. nov.

FIG. 3. Strobile, from life, × 15.
FIG. 4. Lateral view of head of same, bothria directed forward, from life.
FIG. 5. Top of head of same, from life; the bothria are not usually so strongly emarginate in alcoholic specimens.
FIG. 6. Lateral view of head at rest; from life.
FIG. 7. Proboscis, at base, × about 400.
FIG. 8. One view of proboscis about the middle, × about 400.
FIG. 9. Another view of proboscis near the middle, × about 400.
FIG. 10. Embryo(?), from life, × about 200.
FIG. 11. Embryo(?), from alcoholic specimen, × about 200.

Rhynchobothrium hispidum, sp. nov.

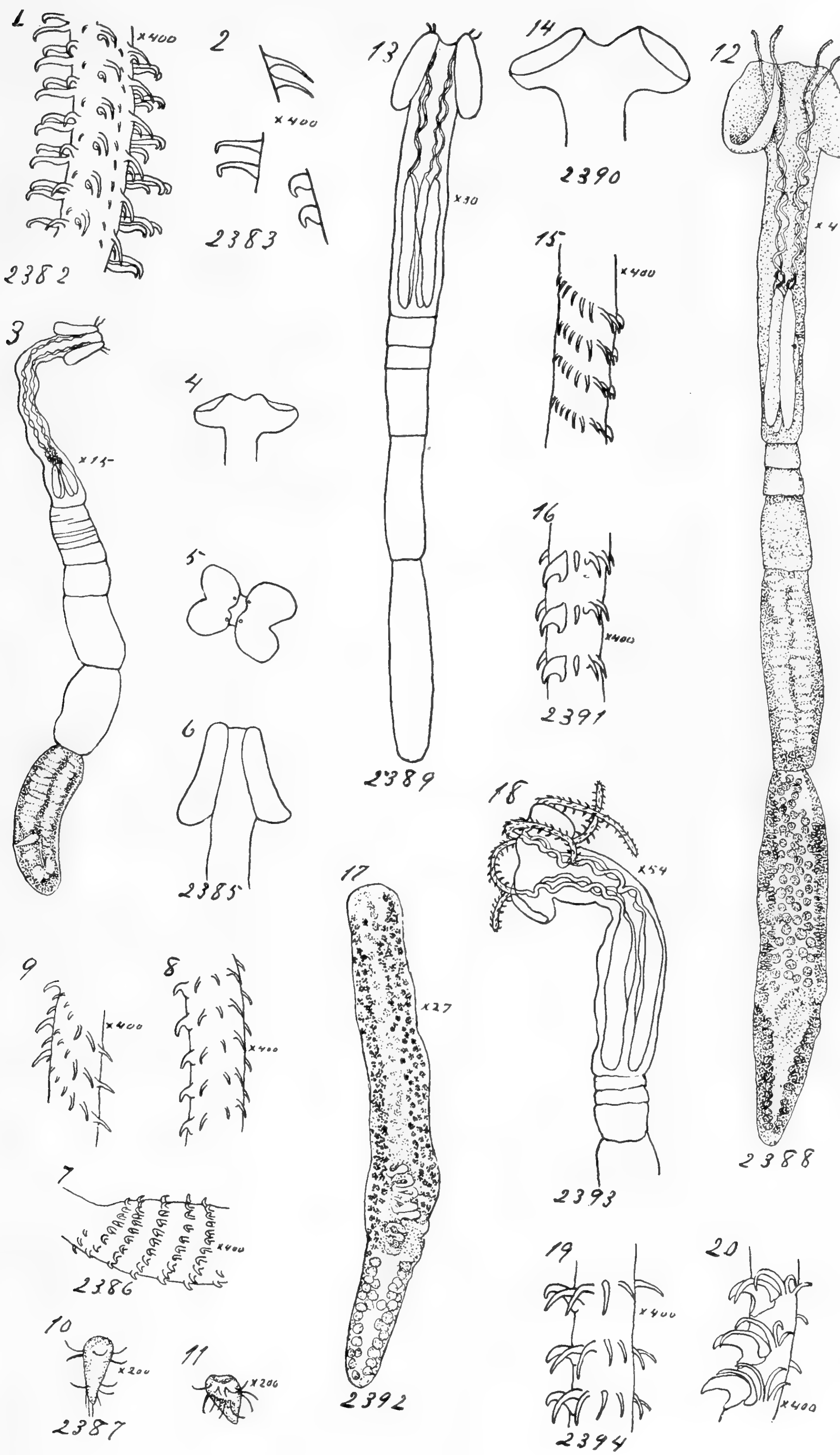
FIG. 12. Strobile, outline from life, some of the details supplied from alcoholic specimen, × 45.
FIG. 13. Strobile, from life, × 30.
FIG. 14. Outline of head, bothria directed forward; from life.
FIG. 15. One view of proboscis, middle, × about 400.
FIG. 16. Another view, near middle, × about 400.
FIG. 17. Mature segment, from alcoholic specimen, × 27.

Rhynchobothrium longispine, sp. nov.

FIG. 18. Head and neck, from alcoholic specimen, × 27.
FIG. 19. One view of proboscis, × about 400.
FIG. 20. Another view of proboscis, × about 400.

All the figures made by Margaret B. Linton.

PLATE XI.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x400
2383
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2390
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x45
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x15
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x400
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x400
2391
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x27
2392
18
x54
2393
9
x400
8
x400
7
x400
2386
10
x200
2387
11
x200
19
x400
2394
20
x400

PLATE XII.

Rhynchobothrium tenuispine, sp. nov.

FIG. 1. Proboscis, near apex, × about 900.
FIG. 2. Tumid base of proboscis, × about 900.

Rhynchobothrium heterospine, sp. nov.

FIG. 3. Head and neck, from alcoholic specimen, × 27.
FIG. 4. Principal forms of hooklets, highly magnified.
FIG. 5. Portion of proboscis, × about 400.
FIG. 6. Posterior segment, from alcoholic specimen, × 4½; *a*, hilum left by separation of this from the preceding segment; *b*, the characteristic notch forming the marginal genital aperture.

Rhynchobothrium imparispine, sp. nov.

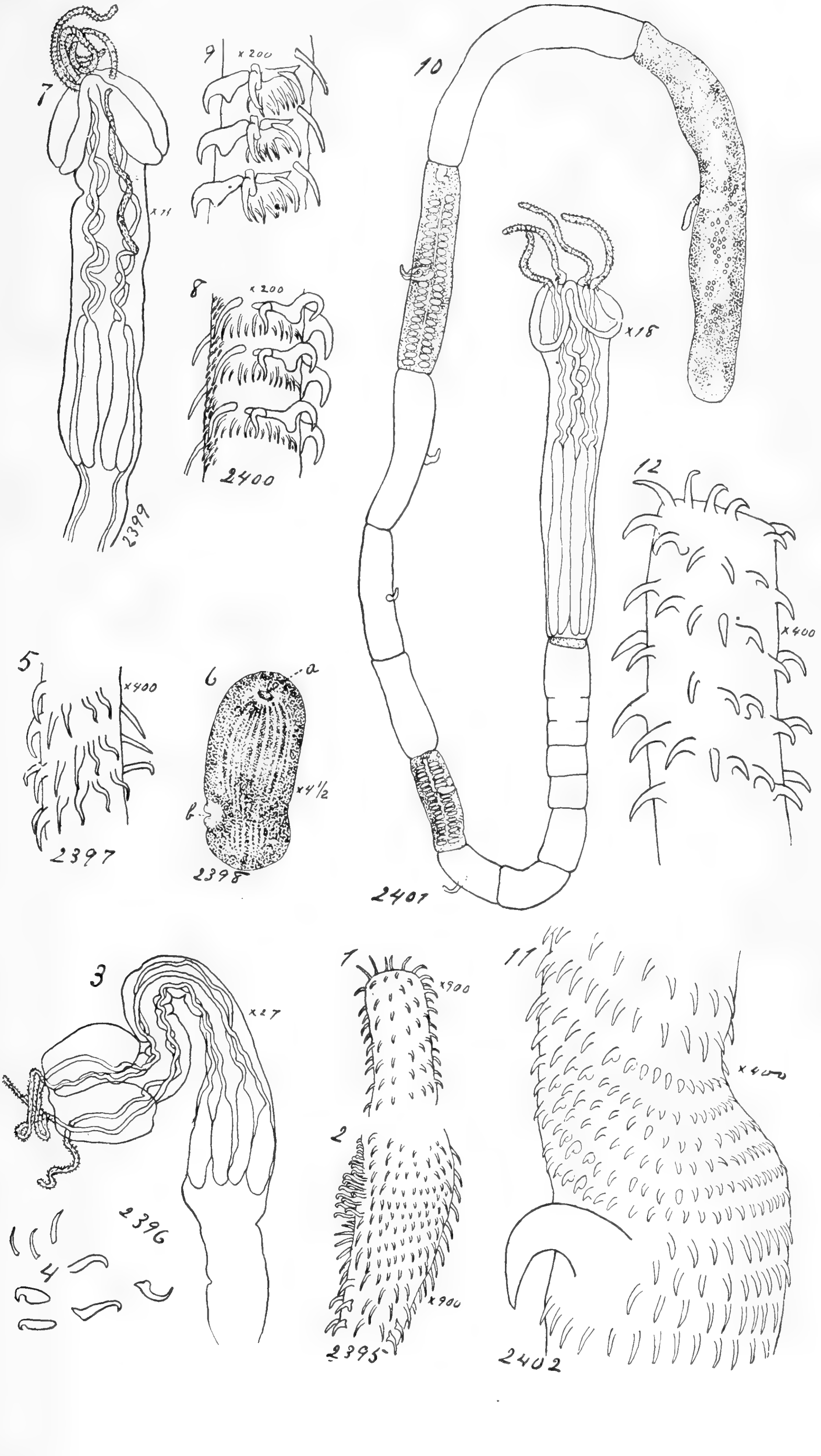
FIG. 7. Head and neck, from alcoholic specimen, × 15.
FIG. 8. Proboscis near middle, × about 200.
FIG. 9. Proboscis near apex, × about 200.

Rhynchobothrium wageneri, sp. nov.

FIG. 10. Strobile, outline from life, details of last segment filled in from alcoholic specimen, × 18.
FIG. 11. Base of proboscis, showing the arrangement and relative sizes of the basal hooks and the single large hook. The latter lies on the outer side of the proboscis as shown in Fig. 10, × about 400.
FIG. 12. Proboscis near apex, × about 400.

All the figures made by Margaret B. Linton.

PLATE XII.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x 11
2399
9
x 200
8
x 200
2400
10
x 18
2401
12
x 400
5
x 400
2397
6
a
b
x 4 1/2
2398
3
x 27
2396
4
1
x 900
2
x 900
2395
11
x 400
2402

PLATE XIII.

Rhynchobothrium lomentaceum Diesing.

FIG. 1. Head and neck, from life, × 4½.
FIG. 2. Fragment of strobile, from life, × 4½.
FIG. 3. Part of proboscis, × about 200.

Rhynchobothrium longicorne, sp. nov.

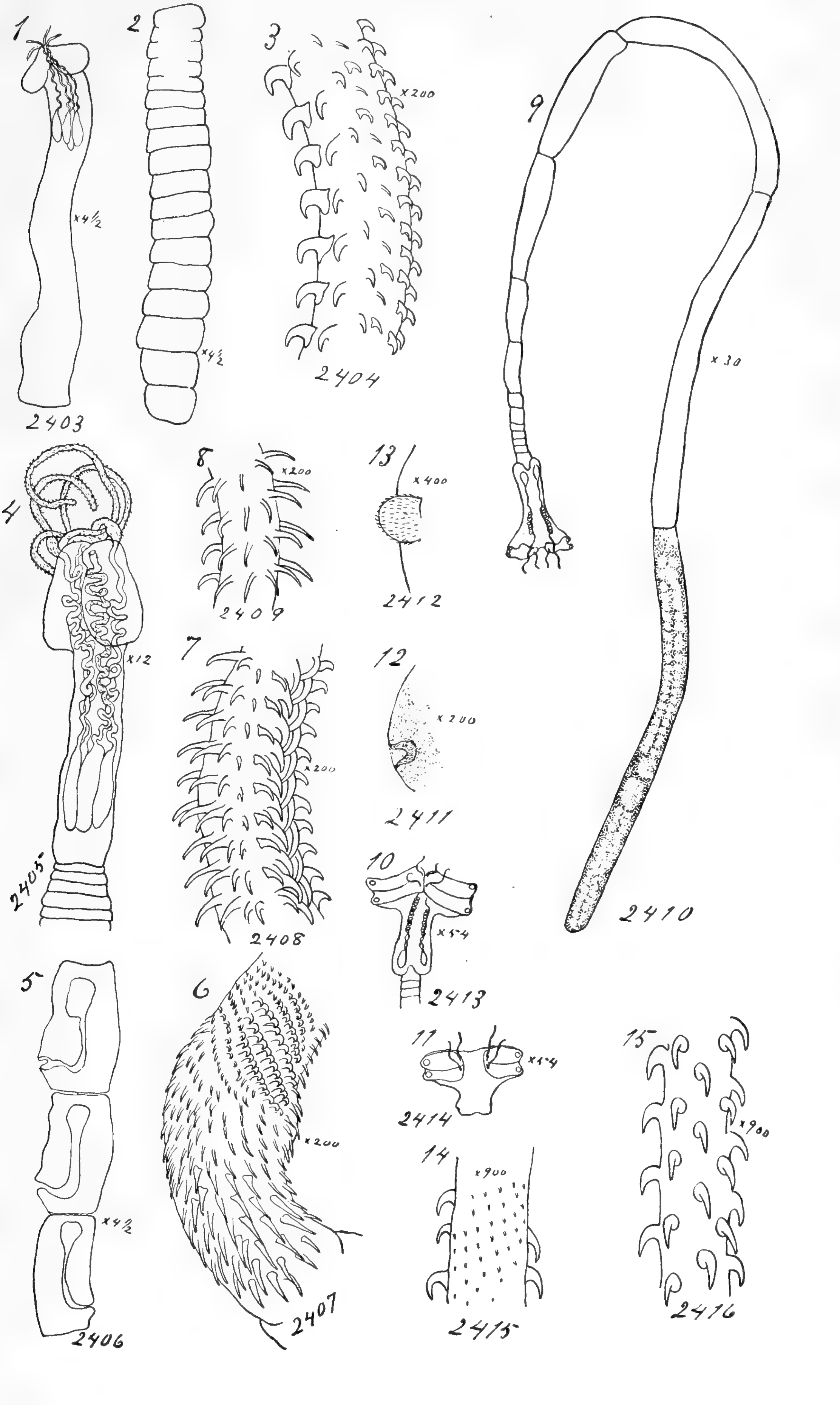
FIG. 4. Head and neck, from alcoholic specimens, × 12.
FIG. 5. Posterior segments, from alcoholic specimens, × 4½.
FIG. 6. Tumid base of proboscis, × about 200.
FIG. 7. Middle of proboscis, × about 200.
FIG. 8. Proboscis near apex, × about 200.

Otobothrium crenacolle, gen. et sp. nov.

FIG. 9. Strobile, outline from life, details of last segment supplied from alcoholic specimen, × 30.
FIG. 10. Lateral view of head, from life, bothria appressed in front, × 54.
FIG. 11. Another view, from life, bothria separated in front, × 54.
FIG. 12. Otosac, retracted and forming a ciliated pit, from alcoholic specimen, × 200.
FIG. 13. Otosac, everted and forming a ciliated papilla.
FIG. 14. Proboscis near base, × about 900. The small hooklets are not always easily seen.
FIG. 15. Proboscis, usual appearance, × about 900.

All the figures made by Margaret B. Linton.

PLATE XIII.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x 4½
2403
2
x 4½
3
x 200
2404
9
x 30
2410
4
x 12
2405
8
x 200
2409
13
x 400
2412
7
x 200
2408
12
x 200
2411
10
x 54
2413
5
x 4½
2406
6
x 200
2407
11
x 54
2414
14
x 900
2415
15
x 900
2416

PLATE XIV.

Otobothrium crenacolle, gen. et sp. nov.

FIG. 1. Outline of strobile, from life, × 8.
FIG. 2. Outline of a more slender strobile, from life, × 10.
FIG. 3. Proglottis, from alcoholic specimen, × 18; *a, a*, ovaries.
FIG. 4. Proglottis, the central portion tumid on account of an aggregation of ova; the size of the latter is somewhat exaggerated in the sketch; from an alcoholic specimen, × 12.

Tetrarhynchus tenue, sp. nov.

FIG. 5. Outline of strobile, from life, × 21.
FIG. 6. Proboscis, × about 400.

Tetrarhynchus robustum, sp. nov.

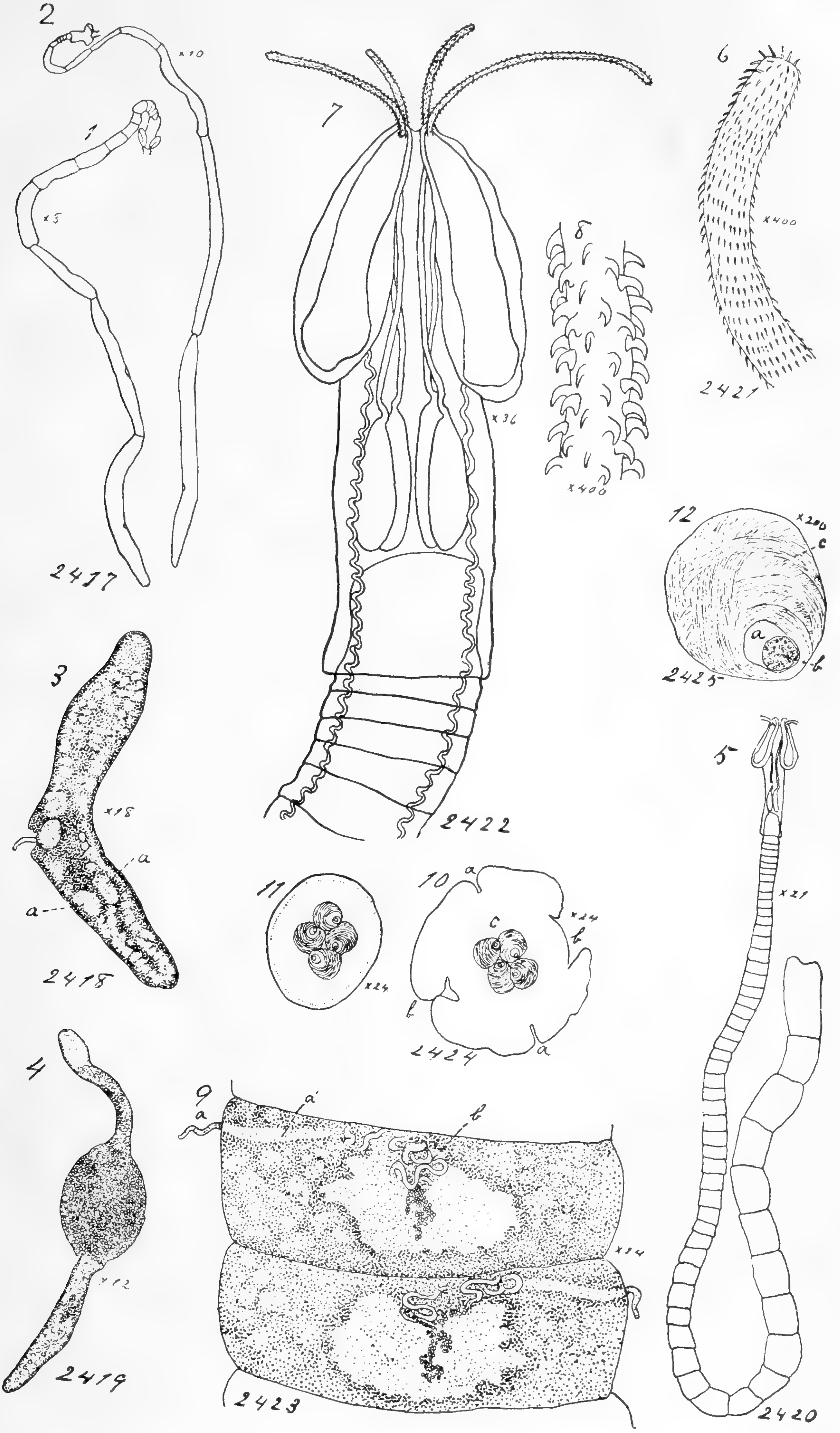
FIG. 7. Head and neck, from life, × 36.
FIG. 8. Proboscis, × about 400.
FIG. 9. Posterior segments with ova, from life, × 24.

Tetrarhynchus bisulcatum Lt.

FIG. 10. Outline of section through base of bothria, × 24; *a, a*, sulci separating the bothria of the lateral pairs from each other; *b, b*, marginal spaces separating the pairs of bothria; *c*, the four contractile bulbs of the proboscides; for an enlarged sketch of one of these sections see Fig. 12.
FIG. 11. Outline of section through the tubular neck and contractile bulbs, × 24.
FIG. 12. Transverse section through a contractile bulb, × about 200: *a*, interior cavity which in life is filled with a fluid containing a few refractile granules, the function of the fluid, when compressed, being to evert the proboscis; *b*, section of retractor muscle; *c*, section of muscular wall of the bulb, showing the alternating layers of diagonal muscles.

All the figures made by Margaret B. Linton.

PLATE XIV.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x10
1
x5
2417
7
x36
2422
8
x400
6
x400
2421
12
x200
c
a
b
2425
3
x18
a
a
2418
11
x24
10
a
x24
c
b
b
a
2424
5
x21
4
x12
2419
9
a
a'
b
x24
2423
2420

PLATE XV.

Tetrarhynchus bisulcatum Lt.

FIG. 1. Portion of pyloric division of the stomach of *Carcharias obscurus* with the parasites attached to the mucous membrane. In some cases two or more scolices are buried in a common pit, × 1½.

Syndesmobothrium filicolle, sp. nov.

FIG. 2. Sketch of alcoholic specimen, × 15. The specimen is immature and the posterior part *a* is evidently a blastocyst from which the anterior part or scolex has been everted.

FIG. 3. Hooks, the smaller ones from the base, the larger from the middle of a proboscis, × 200.

FIG. 4. View of top of head, from alcoholic specimen, × 50.

Paratænia medusia, gen. et sp. nov.

FIG. 5. Strobile; outline from living specimen; details of anatomy supplied from alcoholic specimen, × 15. The last two segments are filled with ova. The tentacular proboscides were everted after the specimen had been placed in alcohol.

FIG. 6. Outline of strobile, from alcoholic specimen, the tentacular proboscides retracted, × 18; *a*, terminal os into which the proboscides are retracted.

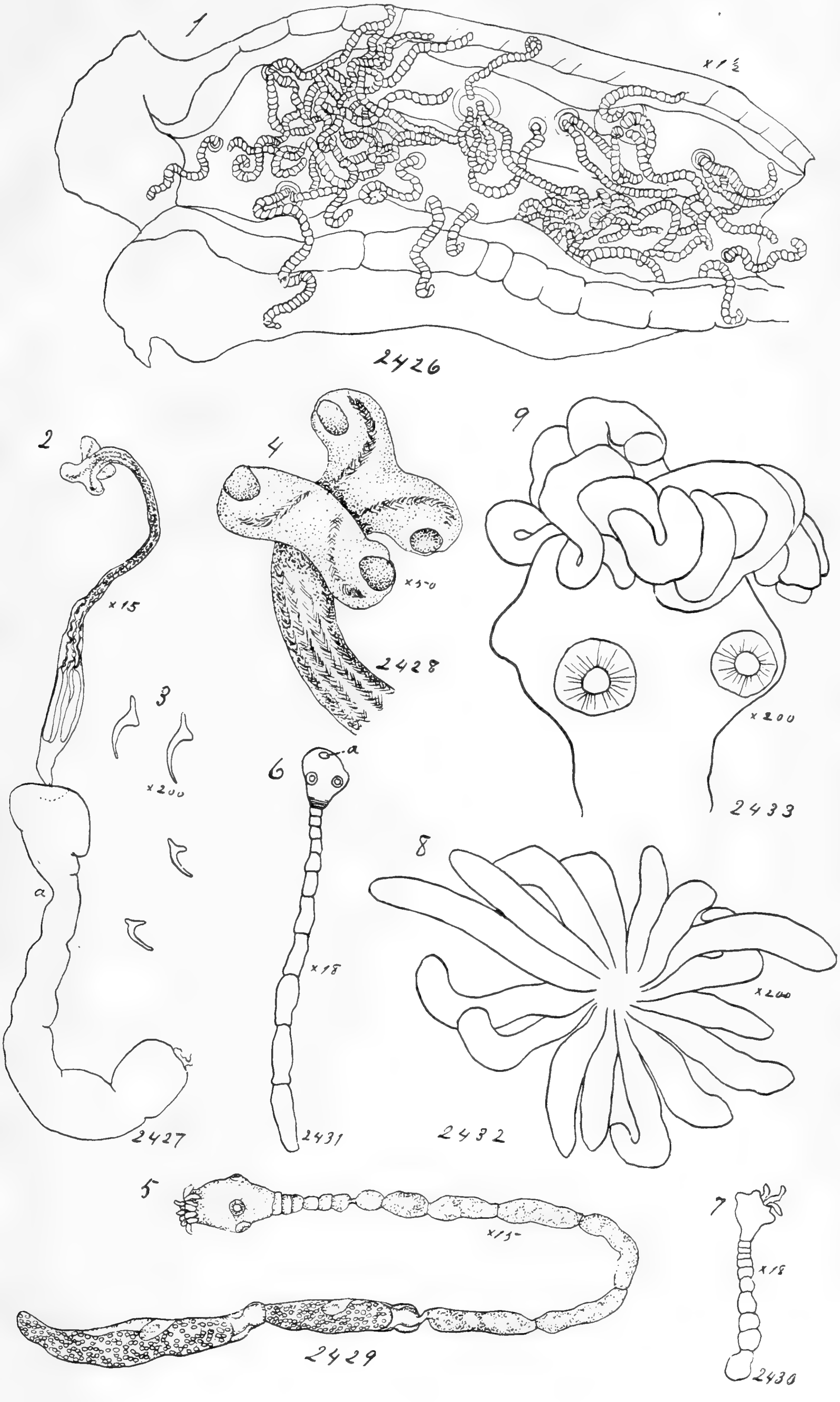
FIG. 7. Outline of strobile with three of the tentacular proboscides protruding, from alcoholic specimen, × 18.

FIG. 8. Top of head, all the tentacular proboscides extended, making a terminal rosette, or sixteen-rayed crown, from alcoholic specimen, × 200.

FIG. 9. Side view of head showing tentacular proboscides and two of the bothria, from alcoholic specimen, × 200.

Figures 6, 7, 8, and 9, by the author, the others by Margaret B. Linton.

PLATE XV.


1
x 1 1/2
2426
2
x 15
3
x 200
a
2427
4
x 50
2428
6
a
x 18
2431
9
x 200
2433
8
x 200
2432
5
x 15
2429
7
x 18
2430

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